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Recent Advancements in Coast and Geodetic Survey Methods

RAYMOND STANTON PATTON

The United States Coast and Geodetic Survey is an old service, dating back to 1807 when Congress passed the first act authorizing a survey of the coasts. President Madison appointed Ferdinand Hassler, a Swiss engineer, the first superintendent of the newly authorized Coast Survey. Hassler was one of the few men of his time to visualize the potentialities of the United States, and in the very beginning he planned for the fuure—and in doing so, brought down all kinds of trouble on his own head. He insisted that all the harbor and coastal surveys be controlled by a backbone of accurate triangulation to extend from one end of the coast to the other. Congress and the political gentlemen of the day could see no necessity for elaborate base measurements and triangulation schemes, and Hassler was looked upon as a crochety old crank. He had a perfectly good opinion of himself, however, and the story is told that, when the President once objected to the high salary he demanded, stating that his proposed pay was greater than that received by the Secretary of the Treasury, Hassler indignantly replied that any President could make a Secretary of Treasury, but that only God Almighty could make a Hassler. His statement must have been convincing for he received the salary demanded.

In these days when we hear so much about plans or the lack of plans, it is interesting to know that Hassler's specifications for triangle closure in primary triangulation have held good for 115 years and are the standard of our present day first-order

triangulation. The triangulation which Hassler himself executed over a hundred years ago is included in our first-order nets of today.

HYDROGRAPHY

While the standards of accuracy have changed but little since Hassler's day, the methods of obtaining these results have undergone almost revolutionary changes. When hydrographic surveys were first started, it was considered necessary to survey only a narrow fringe along the coast. Ships of that day were of light draft—seldom exceeding 15 feet—and they had no means of taking soundings except with the lead line which could be used only in comparatively shoal water. It was, therefore, neither necessary nor possible to extend surveys offshore into deep water.

The early hydrographers located their soundings by sextant angles on objects ashore, and in the rare cases when sounding out of sight of land, they depended entirely upon dead reckoning.

With the introduction of steam in navigation, the time element became important and better and more complete charts were demanded. Surveys were extended farther and farther offshore, and sounding lines had to be spaced closer together to avoid the possibility of missing shoal or rocks, for steamers are prone to cut corners and not go the long way around. As time went on, the sounding machine and pressure tube were perfected and ships could obtain fairly accurate soundings in depths up to 100 fathoms without stopping. Finally, shortly after the World War, echo sounding was introduced and the navigator then had a way of taking continuous soundings at full speed in almost any depth.

The Coast and Geodetic Survey realized the possibilities of this revolutionary method of sounding and in coöperation with a commercial company succeeded in producing an instrument with sufficient accuracy for surveying purposes. All major vessels of the Survey are now equipped for echo sounding, and as a result the output per ship has more than doubled. With the old method using the lead line or pressure tube, speed had to be kept down to 4 to 6 miles per hour, while with the fathometer the vessel can be kept at full speed and get soundings at the rate of four per second.

While the introduction of echo sounding served to expedite our hydrographic work, it also created additional demands on the chart, for the navigator equipped with echo sounding devices wants to know the configuration of the bottom under him while

far at sea. That means that the hydrography must be carried at least to the foot of the continental shelf. To carry out such accurate surveys, improved methods of horizontal control became a prime necessity.

To meet this demand, the Survey developed what is known as radio-acoustic sound ranging. The first experiments began in 1923 and the method has gradually been improved until at the present time a high state of efficiency has been reached. This method is based on the determination by automatic methods of the time required for sound to travel through the water from the ship to two or more shore or floating magnetophone stations, the positions of which are accurately known.

When the surveying ship desires a position, a bomb consisting of a pint or a quart of TNT is thrown overboard and detonated by means of a waterproof fuse. The explosion registers an initial on the ship's chronograph, and when the sound reaches each magnetophone it transmits an automatic radio signal which again is registered on the chronograph. It is then possible to scale off the elapsed time to a hundredth of a second and the time of travel of the sound to each magnetophone is thus determined. The time is then converted to distance, the arcs are swung off from each magnetophone station and the intersection gives the position of the ship.

One of the great advantages of the radio-acoustic method is that work can be carried on at night or in fog. On numerous occasions our vessels have carried on hydrography for a whole week without ever catching a glimpse of the land. It gives one an uncanny feeling to stand in the plotting room of a survey ship on a dark night or in thick fog and see the positions being plotted as accurately as if shore objects were visible. One feels with great exultation that, at least in this phase of survey work, the age-old bugbear of fog or thick weather has been overcome.

Some very curious facts have been observed in our radio-acoustic work. For example, a vessel working off the Alaska coast was barely able to get bombs through at 50 miles offshore, while at the end of the lines about 85 miles offshore, they went through at full force. It has been definitely proven that the configuration of the bottom has a great effect on the transmission of sound, but the actual path taken by the sound waves is still uncertain. On one occasion off the California coast, sound ranging was carried for a distance of 206 miles offshore and the bombs were still

going through comparatively strong when the radio became too weak to operate the chronograph.

For the past two seasons, the Coast and Geodetic Survey has been engaged on a resurvey of Georges Bank, an extensive shoal area lying some 120 miles east of Cape Cod on the Atlantic coast. This survey is unique in several respects. It is controlled by a buoy triangulation, the distance between the buoys being determined by sound ranging and the direction between them by sun azimuths taken from the deck of a vessel when two buoys are in range. The network of triangles is then computed as in land triangulation and remarkably accurate results have been obtained. The sounding lines are controlled by radio-acoustic methods using two magnetophone ships which are anchored near the various buoys. This is the first instance in the history of the service wherein a survey of an extensive area entirely out of sight of land has been carried on using rigid methods of control.

The resurvey of Georges Bank has resulted in the discovery of several deep submarine valleys or gorges along its southern side. The transatlantic steamship routes skirt this edge of the bank and, therefore, cross the valleys at nearly right angles. These gorges are of great importance to shipping, for the navigator equipped with echo sounding immediately recognizes his position when he crosses one of them. Due to the great amount of fog in this section, ships are often forced to run for several days without an astronomical position, and it can readily be understood how highly the navigator appreciates the charting of these underwater landmarks, for by them he is often able to fix his position with entire confidence.

TOPOGRAPHY

In addition to the hydrography, a chart must show the topography of the adjacent shores, for in his piloting the navigator depends a great deal upon landmarks for fixing the ship's position. Since the inception of the Survey, the plane table has been the universal instrument for topographic mapping, but now a new method challenges its supremacy. For a number of years, the Service has been developing aerial photo-topography, and in certain areas it is proving itself superior to any method of ground surveys. It is particularly adapted to regions such as the flat coastal plains of the South Atlantic and Gulf coasts of the United States. An aerial survey of the coast of Florida from the Ten

Thousand Islands country of the west coast around to Ormond on the Atlantic coast has recently been completed. The cost of this work compares very favorably with plane table surveys, and the resulting map shows far more detail and covers more area than would be possible with ground methods. In fact, some parts of this area consisting of mangrove swamps are so inaccessible that accurate and complete ground surveys are almost impossible of execution.

Due to the constant changes (both natural and man made) occurring along our coasts, the problem of keeping the charts up to date is one of considerable difficulty, but one to which aerial surveys are well adapted. Once the basic air photo map is available, there are many fixed points such as highway intersections and buildings, that will serve to control any future air photos which are made for revision purposes. Advances in camera design such as the introduction of the 5-lens camera, are making it possible to produce air photo maps with more accuracy and less expense. While it is probable that aerial photography will never completely supplant the plane table, it is certainly proving superior in certain cases.

CONTROL TRIANGULATION

One of the important functions of the Coast and Geodetic Survey is that of providing control points whereby the surveys of states and other organizations may be properly coördinated and fitted together.

As stated above, the first superintendent laid his plans well and from the very beginning all our coastal surveys were controlled by triangulation. The first great piece of geodetic work accomplished by the Survey was the transcontinental triangulation which roughly followed the 39th parallel of latitude from Cape May, New Jersey, to Point Arena, California. This monumental work was started in 1871 and was completed in 1898. Its primary object was to coördinate the charts on the Atlantic and Gulf coasts with those of the Pacific, but it also furnished control points in the states through which it passed, and provided data for a new determination of the figure of the earth.

By 1899, the total length of first-order triangulation in the United States was about 7,000 miles. Since that time the demand for control surveys has increased to such an extent that the Survey is now working on a plan which calls for arcs of first- and

second-order triangulation at intervals of about 50 miles over the whole country to be completed by 1942. There are at present about 31,500 miles of first-order triangulation in this country (Fig. 1).

FIG. 1—The lines of first-order levels in the United States.

Improved instruments and methods have resulted in rates of progress that would have been considered purely visionary as lately as 30 years ago. There have been great improvements in theodolites. The light compact instruments of today are easily transported and the required precision can be obtained by fewer observations. When Hassler started his work in 1816, he had a special carriage built to transport his great cumbersome theodolite. Now the theodolites used in first-order work can be carried by one man.

Another great improvement was the introduction of night observing on electric signal lamps. Heliotrope work is uncertain because the instruments can be used only during sunshine, and observations can be made only at certain periods of the day when the atmosphere is steady. The modern signal lights have been observed at distances up to 153 miles and they are equally good for the shorter lines of about 10 miles which are in general use now. With our observing parties today, there is seldom a night on which the observations can not be completed.

Probably the greatest factor in accelerating the progress of triangulation has been the use of the portable steel tower known as the Bilby Tower (Fig. 2). These towers were first used in 1927,

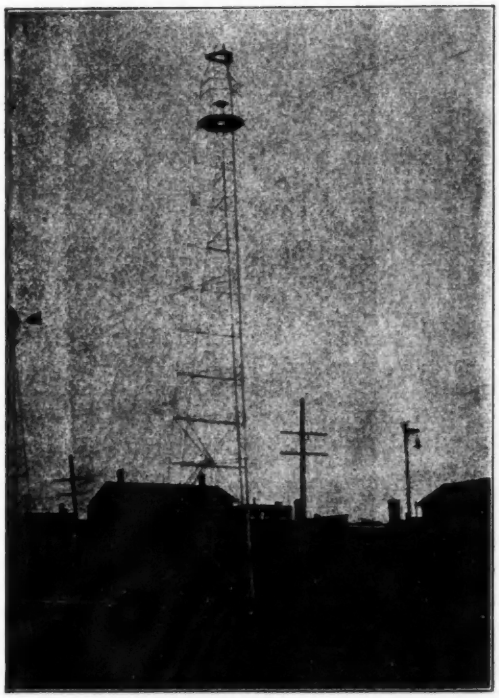

FIG. 2—The Bilby knock-down triangulation tower. Note the outer structure which supports the light and the observers, and the separate inner structure which supports the surveying instruments. This portable tower can be erected in town or country.

and were successful from the very start. The Bilby tower is designed so that it can be erected at any reasonable height. The maximum height to which it has been built is 149 feet for the inner structure and 159 feet for the outer structure. The men employed on the building parties become very expert and it is not unusual for them to have a 100-foot tower completely erected within 5 hours of the arrival of the truck bearing the steel. Such a tower can be taken down in about 3 hours.

In general 10 or 12 such towers are employed in a party. As soon as the observer has completed observations on a tower, it is taken down and sent forward on trailer trucks to a new station. The observers, when they arrive, always find the towers up and the light keepers on the job.

In 1899 it was estimated that the average progress of a double triangulation party should be approximately 40 miles per month. In July, 1931, the party of H. W. Hemple made a progress of 208 miles along the Mississippi River. The 1899 estimate called for the completion of 6 stations per month by such a party while Hemple's party during the same month occupied 48 main scheme stations and made observations at 20 supplemental stations. Notwithstanding the rapidity with which the party carried on observations, there was no delay from lack of prepared stations. While the above figures are the record for rapidity of progress, other parties have frequently made monthly progresses of 190 to 200 miles.

It should also be stated that the introduction of the motor truck and good roads movement throughout the country have been very important factors in speeding up the work.

These improvements in methods have resulted in an almost unbelievable reduction in unit costs. The transcontinental triangulation throughout Indiana and Illinois, for example, cost $1,725 per station, while today in similar terrain the cost per station runs about $300.

In the field of base measurement, the introduction of the invar tape has resulted in great economies. The old-fashioned base measuring bars were not only very slow and cumbersome in operation but they could be used only on comparatively level ground. The use of the steel tape was a distinct forward step but due to the large coefficient of expansion of steel the measurements could be made only at night. The use of invar tapes permits the work to be carried on throughout the day and practically no time is lost. With the old apparatus the measurement of a base of average length required more than a month's time while with the invar tape the same base can be measured in ten days.

DETERMINATION OF LONGITUDE

Great improvements have also been made in astronomic instruments and methods. Prior to the World War, each longitude station had to be connected by a telegraph wire with a station whose longitude was already known. In 1899, a longitude determination required many days. Improvements were made from time to time until in 1907, longitude differences were determined in 11 days.

After the World War, the Coast and Geodetic Survey, in co-

öperation with the Bureau of Standards, succeeded in applying radio signals to the determination of longitude. As a result, a longitude station can now be established any place to which the instruments can be transported. The radio time signals from the Naval Observatory at Washington, D. C., are used by observers of the Survey. In 1925, a party engaged in longitude work in the Aleutian Islands, Western Alaska, received their signals direct from the naval radio station at Annapolis, Maryland. In January, 1931, E. B. Latham, using radio time signals, determined the astronomical longitudes of nine stations in the states of Louisiana, Arkansas and Mississippi. This is at the rate of about 3 days to the station or less than one third of the time required in 1907 for work of similar accuracy.

STUDIES OF TIDES AND CURRENTS

Another function of the Coast and Geodetic Survey is that of making observations and predictions for tides and currents. We are now operating 30 automatic tide gauges at primary stations along our coasts. The principal object of these gauges is to provide hydrographic control and data for the determination of tidal datum planes, the most important of which is mean sea level. In general, it is considered that 19 years' observation will give a value of mean sea level correct to within about one one-hundredth of a foot. At each primary station there is now being established a basic bench mark which is of permanent construction and located in some park or square where it is not apt to be disturbed. Once a sufficiently long series of tidal observations is obtained, the bench mark will be assigned an elevation and this will then be held fixed as far as mapping and surveying is concerned.

The plane of mean sea level is the only plane whereby quantitative data on the rising or sinking of the coastline can be had, and if present plans are continued, scientists of the future will have available long series of tidal observations accurately referenced to permanent bench marks from which any change in the elevation of the land can be determined with certainty.

You have no doubt heard of our tide predicting machine which was designed and constructed in the Survey and put into operation in 1910. This is a marvelous machine in which the Service takes just pride. Accurate tidal predictions can be tabulated for any port where a series of tidal observations has been made, and

one man can tabulate a year's high and low waters in about one day's time. Tide tables are published in advance for the benefit of mariners and others interested, not the least being the people who wish to know the time of low tide so that they can go clamming.

A recently assigned function of the Survey is making comprehensive current surveys in harbors and important areas along the coast. From these data, current tables are also published annually in advance. This information is of great importance to shipping and is eagerly sought by persons engaged on engineering plans and in scientific studies, such as shoreline changes, etc. The machine used for predicting tides is also used in predicting currents.

TERRESTRIAL MAGNETISM

In the department of terrestrial magnetism, improvements in the instruments at the five magnetic observatories have resulted in great savings in the work of tabulation and preparing the data for publication. The measurement of magnetic elements and changes in the electrical condition of the earth recently has become important to the geophysical prospector in his search for ores and oils. To make these data promptly available, the magnetic character of the day is broadcast over the radio from data obtained from our observatory at Tucson, Arizona. Photographic records of magnetic variation are furnished various government and business research institutions for studies of telegraphic and radio transmission. In fact, the earth's magnetism affects so many of our modern scientific problems that the data from our magnetic observatories are becoming more and more sought after.

In 1925, legislation was enacted authorizing seismological investigations by the Coast and Geodetic Survey. We are now operating eight seismographs and records are or soon will be received from six other stations in North and South America. In California we have about 20,000 correspondents who submit reports on all earthquakes felt. Many improvements have been made on seismographs and new instruments such as the tilt meter and the strong motion seismograph are being developed. Engineers and architects are working on the problem of designing structures that will resist violent earth movements and it is important that the former estimates from observed effects be replaced by accurate measurements.

The Survey publishes monthly instrumental reports on all earth-

quakes recorded on its seismographs and an annual report which covers all the non-important earthquakes in the United States and outlying possessions. These statistics are much desired by various insurance companies as well as by those interested in the purely scientific side of the problem.

AIRWAY MAPS

Another activity which has recently been delegated to the Coast and Geodetic Survey is the compilation and production of airway maps for use in civil aviation. Two types of maps are produced: the strip map and the sectional map. The former covers the principal air routes throughout the interior of the country while the latter are designed to cover the entire country in rectangles corresponding to those laid out for the International Millionth Map of the World, except that they are on a scale of one to five hundred thousand, and two maps, known as the upper and the lower, cover one rectangle. The indexing of these maps follows the system laid out for the world map. Our airway maps are compiled from the best existing data, principally the United States Geological Survey topographic sheets, and are then sent to the field for careful flight checking to insure that no landmarks useful to the aviator are omitted. The present tendency is to show as little detail as possible and to emphasize the important features such as landing fields, railroads, improved highways and rivers, or any other objects prominent from the air. The subject of airway mapping is now in the formative stage and there are differences of opinion as to the best type of map. As aviation advances and improves there will no doubt be changes in the type of map needed.

The Agricultural Geography of Jamaica

R. H. WHITBECK

THE HISTORICAL BACKGROUND

During the latter part of the 18th and the first decade of the 19th centuries, when British North American colonies were gaining and trying their independence, the island of Jamaica was the wealthiest and most prosperous of all the island colonies of the British Empire. Britain and other European powers then placed a very high value upon their tropical islands, partly because the only commercial source of sugar at that time was cane—a tropical plant. European nations were then able to produce at home nearly all of the temperate-zone foodstuffs that they required; hence tropical colonies were more highly prized than any others. It is probable that England, if forced to a choice in 1780, would have chosen to retain her West Indian islands in preference to the thirteen North American colonies which she lost. Jamaica was the greatest of sugar-producing colonies.[1] There were hundreds of estates, worked by slaves, and some of them yielded their owners princely incomes. A few of the proprietors had a thousand or even two thousand slaves and their estates represented investments running into hundreds of thousands of dollars.[2] Beet sugar was practically unknown, and the world's demand for cane sugar often outran the supply; and rum, made from the molasses, yielded an added profit. The slave trade itself was exceedingly profitable during this period, money flowed freely, planters lived sumptuously, and entertained lavishly.[3]

During one period the salary and allowance of the governor of the island amounted to about $50,000 a year; and this governorship was deemed one of the three most desirable in the British Empire,[4] (India, Ireland, and Jamaica). Even certain Church-of-England clergymen in Jamaica had livings (including fees) of $10,000 to $15,000 a year.[4] The general prosperity reached its

[1]Gardner, W. J.: History of Jamaica, p. 84 (1873 and 1909).

[2]*Ibid.*, p. 156.

[3]See Lady Nugent's *Journal* covering period of 1801-1815, edited by Frank Cundall (Kingston) and published in 1906. Also see Bryan Edwards: History of the British West Indies (1st ed. 1793; 5th ed., 5 vols., 1819).

[4]Stewart, J.: The Island of Jamaica, p. 149 (1823).

high point about 1805, during the Napoleonic wars and before beet sugar arose as a competitor. At this time, "West India planter" and "West India merchant" were synonyms for men of large wealth.[5] On the other hand, this period is said to have been one of shocking immorality, and of great brutality toward slaves.[6]

But abounding prosperity did not endure, and after 1805 the sugar industry declined rather constantly. The slave trade was terminated in the Britsh West Indies in 1807, and slavery was abolished in 1834-8, but economic conditions had reached a distressing state before abolition. Ex-slaveholders attributed much more of the island's distress to the abolition of slavery than the facts justified.[7] The freedmen refused to work regularly and the estates were only partially tilled, usually at a loss, and became even more weighed down with mortgages than they were before. Planters in large numbers left their estates in charge of agents and departed from the island. Absentee ownership became a disturbing problem. Between 1839 and 1871 no less than 391 sugar estates and 359 coffee estates were thrown out of cultivation.[8]

In 1820, Jamaica had about 350,000 slaves and 35,000 free whites, a ratio of 10 to 1. Now (1932), there are about 15,000 whites and 900,000 colored and black, or 60 to 1. During the greater part of the half century following the abolition of slavery, Jamaica was in a pitiable economic condition, although other causes than abolition contributed to the general disaster, and probably contributed more than the embittered old slaveholders were willing to concede.[9] Bounty-fed beet sugar from Europe invaded the British market, and more efficient methods of cane sugar production were arising in other places. The depression and discontent in the British West Indies formed one of the painful problems of the British government, and it was far from clear how the problem was to be solved.

For various reasons, England was losing much of her former interest in the West Indies. A new nation, the United States, had been born in the Western World and because of nearness seemed destined to rise to dominance in the Caribbean. The West

[5]See Pitman, Frank W.: The Development of the British West Indies, 1700-1763 (1917).

[6]Stewart, J.: The Island of Jamaica, Chs. 11 and 12 (1823).

[7]See Handbook of Jamaica, 1881: Petition to the Prince Regent, p. 349.

[8]Cundall, Frank: Jamaica in 1924, p. 143.

[9]See Ragatz, Lowell J.: The Fall of the Planter Class in the British Caribbean (1928).

Indian colonies felt themselves neglected. From the most prosperous of colonies, they fell to about the most discontented. During the greater part of the past century the British West Indies have suffered severely from recurring periods of financial depression. The smaller of them—the Windward and Leeward Islands —are still struggling, but Trinidad and Jamaica have found new sources of income, and during the years just prior to 1930 were fairly prosperous, except for the declining price of sugar.

THE ISLAND AS A WHOLE: ITS PEOPLE

Jamaica is third in size among the West Indies (Cuba, Haiti, Jamaica), being 144 miles in extreme length and 49 miles in extreme width, and having an area of about 4,450 square miles (2,692,587 acres),[10] or about half the area of New Jersey. Assuming the population to be 915,000, the island's density is more than 200 to the square mile. Porto Rico has about 450, and Barbados has 900 to the square mile. There is no serious problem of over-population in Jamaica, partly because of the steady migration of Jamaican laborers to other parts of the Caribbean, especially to the cane fields of Cuba, to the Panama Canal Zone, and to the banana plantations of Central America. Farm wages in Jamaica are low (50 to 75 cents a day), and the colored laborers are pitifully poor, but no more so than those in most other Caribbean lands. Even the white agricultural laborers in Porto Rico are equally poor.

The people of Jamaica are largely self-governing under the leadership of a small minority of whites. It is, on the whole, a well-governed island, and I doubt if there is any place where the descendants of African slaves receive better justice and have better opportunities to work out their own salvation than they have in Jamaica. They hold most of the local offices, fill nearly all of the civil service positions, constitute the insular police force, run the electric and steam railways, and supply the laborers for most of the industries. Colored girls are the office workers and shop clerks and school teachers. In large offices in Kingston, employing scores of workers, practically every one is colored; as a rule they are a clean, well-dressed, well-behaved and self-respecting group. Many lawyers, doctors, dentists, engineers, actuaries, accountants and other professional men are people of color, usually brown or lighter. Many of these people are as cultured as white people of the same economic status. There is admittedly

[10]Cundall, Frank: Jamaica in 1928, p. 112.

a color line, or color lines, in Jamaica, but there is as much caste feeling and caste practice between the light colored negroes and the full blacks as between the white and colored groups. However, there is no such uncompromising color distinction as prevails in the United States. White, colored, and black people work together without much evidence of caste attitude, although such feeling is by no means absent. Most of the whites living in the island are of British stock and they are a dignified and tolerant people. The color question is sanely handled, and most colored Jamaicans are proud to be British citizens and do not wish to be anything else. But this does not mean that the 900,000 colored Jamaicans have anything like the initiative, enterprise, ambition or varied abilities of 900,000 Canadians, for example. Crime of the more serious sort is not frequent, although pilfering and predial larceny are common. As a race, the negroes are still in their childhood, and this must be kept in mind in considering Jamaica or any other land where they constitute the greater part of the population.

THE PHYSICAL FEATURES AND THE LAND[11]

Like most of the West Indies, Jamaica is extremely mountainous. It was long ago recognized that these islands are the higher parts of a mountain system protruding above the sea. The lower parts of the system are submerged. The Blue Mountains dominate the eastern third of the island. They are a complexly-folded, maturely dissected, ancient mountain mass "marked by deeply etched knife edge salients and angular re-entrants which present the aspect of a crumpled handkerchief picked up by the middle." They rise to heights of over 7,000 feet and are nearly always wrapped in clouds. Rugged as these mountains are, they are well populated up to 4,000 feet altitude, and coffee plantations are numerous at elevations between 2,000 and 4,000 feet.

Completely encircling the Blue Mountains and extending westward over the greater part of the island is a much-dissected limestone plateau whose residual hilltops reach altitudes of 3,000 feet. This limestone plateau, extending over nearly three-fourths of the island, is deeply valleyed by stream erosion and deeply

[11]Hill, R. T.: The Geology and Physical Geography of Jamaica, in *Bull. Museum Comp. Zool.*, Harvard Univ., Vol. 34, 1899. Large folded contour and geol. maps. See also Hill, R. T.: Geology of Cuba, Porto Rico and the other West Indies (1898). For a bibliography of the geology and physical geography see Handbook of Jamaica, Kingston (1923).

pitted by solution. The Cock Pit Country in the northwest is a maze of deep sinkholes (up to 500 feet in depth) connected by underground drainage channels. It is one of the most desolate, difficult, and thinly-populated terrains of the island.

In this denuded limestone plateau are also broad enclosed basins, many square miles in extent, due to erosion and solution. Some of the basins have surface drainage to the sea, and others do not. The largest of these basins are the valley of St. Thomas in the Vale, the Vale of Clarendon, the Hector River Basin, and the Niagara River Valley. The Vale of Clarendon is roughly 50 by 20 miles in area. Most of these basins are regions of limestone soil and include some of the best agricultural land of Jamaica.

Encircling the island is an interrupted coastal lowland averaging only a few miles in width. In places it pinches out to nothing, and elsewhere broadens to local plains 5 miles wide or more. One of the largest of these is the Liguanea Plain nearly 200 square miles in extent, lying north and west of Kingston, the chief city of the island. This plain is semi-arid and much of it is of little agricultural use except where irrigated. There is another irrigated section at the extreme eastern end of the island (Fig. 2). A broadening of the tillable lands on a part of the north shore forms the leading banana-growing region of the island, centered in the parish of St. Mary (Fig. 3).

Of Jamaica's 4,450 square miles, only about 600 square miles (14%) are classed as level land, and a considerable part of this is infertile. Mountainous as the island is, half its area lies below the 1,000-foot contour (Table II). The largest of the level areas are alluvial plains on the south side, parts of which, unfortunately, are deficient in rainfall. However, the alluvial lands are the chief agricultural lands of the island. Less than 300,000 acres (10% of the total land) are actually producing cultivated crops. About 18% of the island is so unattractive for occupation that it still remains in government ownership.

TABLE I. THE LAND OF JAMAICA[12]

Classification	*Acreage*	*Percentage*
Total area	2,692,587	100
Wood and ruinate	ca. 1,000,000	38
Used mainly for pasturage	ca. 853,000	31
Public land	ca. 483,000	18
Under cultivated crops	ca. 278,000	10
Unclassified	ca. 78,587	3

[12]Jamaica in 1928, p. 112. Handbook of Jamaica, 1927, p. 22.

TABLE II.—AREA OF LANDS AT VARIOUS ELEVATIONS[12]

Elevation	*Square Miles*	*Percentage*
Below 1,000 feet	2,288	52
Between 1,000 and 2,000 feet	1,521	34
Between 2,000 and 3,000 feet	458	10
Between 3,000 and 4,000 feet	89	2
Between 4,000 and 5,000 feet	55	1
Above 5,000 feet	39	1
Total	4,450	100

Here is an island whose land surface is so unfavorable that after four centuries only 10% is under cultivation. However, this situation is improved by the fact that there is pasturage for about 140,000 live stock, mainly cattle raised for beef or draught.

How can nearly a million people, requiring a governmental budget of over $10,000,000 a year, maintain themselves on such a small productive area? If all of Jamaica's 278,000 acres of cultivated land produced wheat at the United States average of 15 bushels per acre (and selling for $1.25 per bushel), the return from the entire crop would be $5,200,000, or about half enough to pay the annual cost of the insular government. The cotton lands of the United States yield about the same value per acre as the wheat lands. Obviously, crops of much greater value per acre than wheat or cotton must be raised in Jamaica. The island has practically no mineral or manufacturing industries and there is very little primary income from other than agricultural sources. Jamaica lives almost wholly by tropical agriculture of specialized kinds, supplemented by the raising of cattle. All of the cultivated crops of this island are grown on an area less than 1/100 the size of the state of Ohio, and yet the island was once regarded as one of the richest colonies of the British Empire.

THE CLIMATE[13]

The climate of Jamaica does not differ essentially from that of the other Greater Antilles. It lies in the belt of Northeast Trades, near the northern margin of the tropics. The seasonal range of temperature is small. Frost is unknown and crops grow throughout the year. Even the traditional wet and dry seasons are not strongly marked. (Fig. 1.) The rainiest month over the island as a whole is October (50-year mean, 9.15 in.). The heaviest rainfall is, of course, in the northeastern section, where the Blue Mountains rise athwart the saturated Trade Winds. One station

[13]The Handbook of Jamaica for 1881 includes a special discussion of climate. The Handbooks, issued yearly, contain current climatic data.

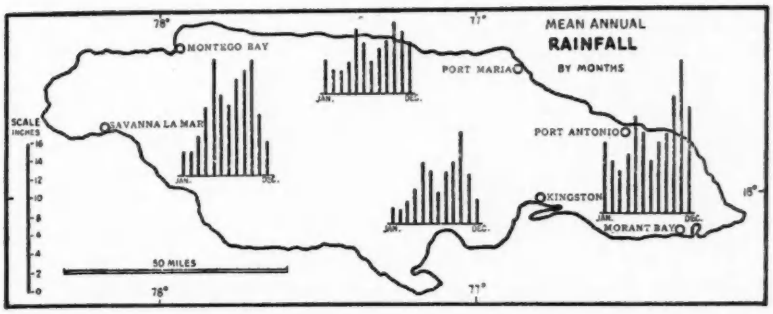

FIG. 1—Types of rainfall in four sections of Jamaica: West center, 50 stations, mean, 90 inches; North, 92 stations, 58 inches; South, 54 stations, 54 inches; Northeast, windward side of Blue Mts., 43 stations, 105 inches.

in these mountains commonly receives 150–200 inches a year. The south coast, lying in the lea of the mountains, receives the lightest annual precipitation, Kingston receiving only about 37 inches. Even this would seem to be sufficient for agriculture, yet the evaporation is very high and the alluvial land is very porous. The extensive plain upon which Kingston lies has a semi-arid flora.

One of the serious handicaps suffered by the island is the all-too-frequent occurrence of droughts that reduce or ruin the crops and dry the pastures. The other menace is the terrible West Indian hurricanes whose destructive visits are irregular, but average one in about seven years. Rarely does a hurricane devastate the whole island. In 1915, 1916 and 1917, hurricanes visited the island each year and reduced the banana crop to about 15% of its average yield. None has occurred since (to Feb. 1932), but the planters of Jamaica live under the threat of disaster every autumn (August to November), and all of the business of the island must take into account the possibility of one of these terrible storms. The three successive hurricanes of 1915-17 brought the island to the verge of bankruptcy and entailed prolonged suffering upon tens of thousands of people.

So far as its climate is concerned, Jamaica is able to raise a wide range of products—sugar, cotton, coffee, cacao, coconuts, tobacco, many kinds of fruits and many kinds of vegetables, and it does raise all of them; but bananas and sugar are the outstanding cash crops, with sugar on the decline and bananas increasing.

SUGAR

For about two centuries, Jamaica raised sugar cane as its major crop, and was one of the world's foremost sugar producers. The largest production (over 100,000 tons)[14] was reached in 1805. The sugar estates are mostly near the coast where rea-

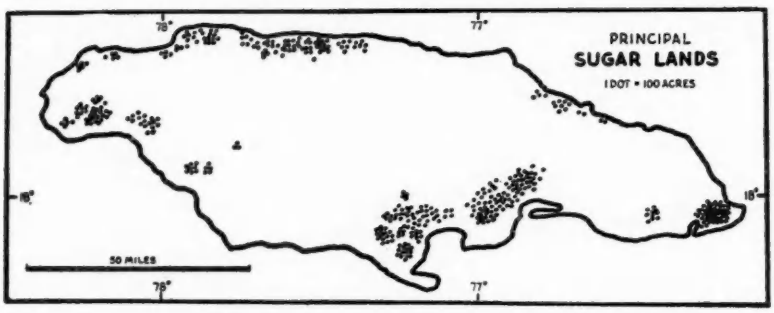

FIG. 2—Sugar cane in Jamaica is grown mainly on alluvial lands. The sugar estates usually occupy several hundred acres each, in all 40,000 acres of cane, served by about 40 sugar mills, mostly steam driven. Irrigation is largely employed on the estates on the south side of the island.

sonably level land and ports are available (Fig. 2). Sometimes this crop is exceedingly profitable and sometimes ruinously unprofitable. Omitting the period of the World War (say 1915 to 1920) the sugar industry in the British West Indies has been unsatisfactory a greater part of the time for a century. The United States tariff gives a preferential duty to Cuban sugar and places no duty at all on Porto Rican sugar. This means that Jamaican sugar is virtually excluded from the United States, the only large nearby market. Sugar produced within the British Empire enjoys (at present) a preferential duty in the British Isles, but this is not sufficient to yield any profit to the British West Indian sugar growers, under present prices. In fact, the sugar industry is a losing venture everywhere because of present overproduction and consequent ruinous prices.

Sugar is third in acreage and second in export value among Jamaican products, and usually constitutes between 12 and 16% of the value of the island's exports. Sugar land is increasingly being planted to bananas, which now occupy twice the acreage of

[14]Bigelow, John: Jamaica in 1850, pp. 201-3 (1851), gives tables of annual production of leading crops for years 1772 to 1848.

sugar cane (Table III). Great sugar centrals turning out 50,000 to 100,000 tons of raw sugar annually, as the large ones in Cuba and Porto Rico do, do not exist and would not be practicable in Jamaica. The largest mill in the island turns out only about 8,000 tons a year, and some 16 to 18 mills exceed 1,000 tons yearly.[15] Most of the 40 mills now in use are steam-driven mills of the smaller size, yet vastly larger and more modern than the 6,000 little mills of a few generations ago. Eight *large* sugar estates (over 1,000 acres of cane each) are in operation.[15] Sugar is not suited to small-scale production. It is essentially a capitalist crop. Only when sugar prices are nearly double the present ones, and only when tariff favors are given by the British Isles, can Jamaican sugar growers make a fair return on their investment.

THE PRE-EMINENCE OF BANANAS

The impressive contrast between the course of agricultural development in Porto Rico and in Jamaica, two West Indian islands of very similar physical conditions, shows the dominating influence of the United States tariff upon the economic life of those islands. Porto Rico, quite naturally, has the most favorable tariff relations with the United States of any of the West Indies; but bananas enter the United States duty free, and for her bananas Jamaica therefore enjoys the free access to that great market. This difference has brought it to pass that sugar cane is the chief crop in Porto Rico and bananas the chief crop in Jamaica.[16]

The Jamaican banana growers are usually quite prosperous. They exported 22,000,000 stems[17] of bananas in 1929, receiving therefor over $12,000,000; this is a return to the grower of 60 cents a bunch[17] or $133 per acre of average land planted to bananas. Of course the best land produces much more than this. Two American fruit companies have acquired large land holdings and their fine banana plantations extend for miles on both the north and the south sides of the island. Bananas are raised almost everywhere in Jamaica, but the eastern part of the northern slope (Fig. 3) is more productive than elsewhere, partly because of greater rainfall. The Banana Growers Association, organized a few years ago, has over 10,000 planter-members who

[15] Handbook of Jamaica, annual.

[16] The shipment of bananas from Jamaica dates from 1876.

[17] A stem of bananas having 9 or more hands is classed as a "bunch." If it has 8 hands it is classed as three-fourths of a bunch; 7 hands is one-half of a bunch; 6 hands is one-quarter of a bunch.

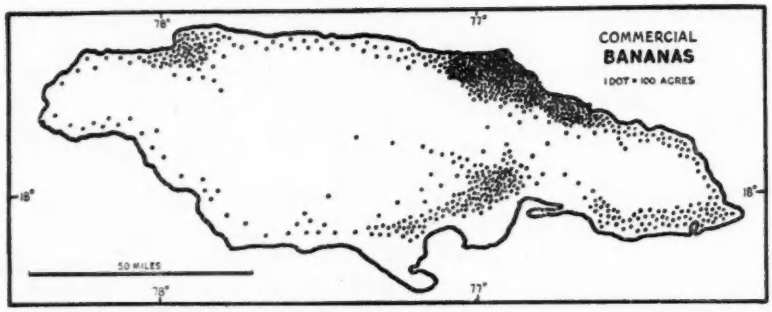

FIG. 3—Beginning a half century ago, commercial banana growing has become the outstanding industry of Jamaica. About 90,000 acres are devoted to this crop, grown both by thousands of small planters and a few great corporations. One of the latter has 9,000 acres planted to this crop. Over 20 million bunches are shipped annually from the island.

market their fruit coöperatively, and try thus to liberate themselves from the control of American fruit companies. The extent to which small planters are engaged in growing bananas is seen in the fact that of more than 11,000 growers only about 30 have 300 or more acres of bananas, and less than 400 planters have more than 20 acres each. On the contrary, the United Fruit Company, according to the Handbook of Jamaica for 1931, has 36 estates covering 7,000 acres "in bananas," and is the dominating power in the banana industry.[18] Banana growing is suited both to the small planter and to the great fruit company.

Unlike most of the banana lands of Central America, those of Jamaica seem able, with only moderate fertilizing, to go on producing good fruit year after year. Some of the older banana properties have been producing for a half century. Many of the plantations on the south side of the island get insufficient water from rainfall and this land must be irrigated. The best of these irrigated estates produce most excellent fruit in large quantities. Such irrigated lands may sell as high as $1,000 an acre. Jamaican bananas are not so large as the Central American, but they find a ready market in both England and the United States. Increasing shipments are going to the British Isles, partly in the ships of the Producer's Association, and Jamaican bananas are given tariff favors in Canada. The United States, however, takes from

[18]The Annual Report of the company for 1931 gives the acreage of its banana cultivations in Jamaica as 9,020.

one-half to two-thirds of the bananas exported from Jamaica. As one drives through mountainous parts of the island he is surprised to see field after field of fine bananas growing on rather steep slopes. Some of the best fruit comes from these small holdings back in the interior where new land is being brought under cultivation.

Bananas are a much better small-farm crop than sugar, for they may be marketed every week of the year. A man with only an acre or two may have a weekly income during most of the year. The building of excellent roads throughout the island,[19] and the coming of the motor truck make it easy for almost any small grower to market his bananas, for the buyer's trucks pick up fruit along the main roads. More and more land is being given over to this crop, and Jamaica is relatively more prosperous, at present than any of the other West Indies except possibly Trinidad, which has important asphalt and petroleum industries in addition to diversified agriculture.

The three enemies of the banana grower are hurricanes, droughts, and the Panama disease. The hurricanes are, as a rule, infrequent, the droughts affect only parts of the island, but the Panama disease is threatening practically every section. Experts are fighting it and holding it under control, and, on the whole, the banana industry in Jamaica has become one of the most successful of the agricultural industries of the Caribbean region.

THE IMPORTANCE OF TREE CROPS

In spite of the preponderance of bananas, Jamaica is not a one-crop country to any such extent as Cuba and Porto Rico are. It is at present notably a land of tree crops, if bananas may be classed as such. This fact is related to the mountainous topography, where tree crops are more suitable than any other kind; yet tree crops have not always predominated in Jamaica, nor do they now predominate in other mountainous islands of the West Indies. Of the 278,000 acres of cultivated land, about 100,000 acres are devoted to sugar cane and ground provisions, while most of the remaining 178,000 acres are devoted to tree crops, especially to bananas, coconuts, coffee and cacao, but also to oranges, grapefruit, pimento, logwood, breadfruit, and mangoes.

The coconut palm grows throughout the island, both in scat-

[19] More than 2,000 miles of excellent, hard-surfaced roads, in addition to over 2,000 miles of "light motor roads."

tered groves and in orderly plantations. The principal coconut plantations are near the sea and in the eastern third of the island. A mature tree yields annually 50 to 100 nuts which bring the grower about 3 cents each, or an average of 50 to 75 dollars an acre. From 40,000 acres of coconut lands, Jamaica annually exports about 25,000,000 coconuts and 10,000,000 pounds of copra (the dried meat of the coconut), which together form about 5% of the value of all exports. Coconuts are easy to grow and require little attention after the trees are started.

Coffee was at one time the leading crop of the island. In 1814, Jamaica had about 800 coffee plantations and produced 30,000,000 pounds.[20] The present acreage and production have fallen much below these figures, but coffee is still about fifth in acreage. The Blue Mountain coffee is said to be the most expensive in the world's market. The coffee is usually grown on steep slopes at fairly high altitudes, especially in the Blue Mountains. Its high value permits mule-back or man-back transportation. The chief coffee lands follow the central mountain backbone of the island. It grows almost exclusively in the shade of other trees, and is grown mainly by small proprietors.

TABLE III.—UTILIZATION OF LAND IN JAMAICA, 1930.[21]

Crop	*Acres (Approximate)*	*Land Utilization*	*Acres (Approximate)*
Bananas	90,000	Guinea grass	100,000
Ground provisions	54,000	Common pasture	700,000
Sugar cane	44,000	Pasture with pimento	53,000
Coconuts	40,000	Public land	483,000
Coffee	18,400	Wood and ruinate land	1,000,000
Cacao	4,600	Unclassified	78,587
			2,414,587
Miscellaneous	27,000	Under cultivation	278,000
Total under actual cultivation	278,000	Total land area	2,692,587

CATTLE RAISING

The best beef cattle and the best milk cattle are of course found outside the tropics, yet cattle raising has been a leading industry in Jamaica since the Spanish Colonial days. The geographic reason is that in this hilly and mountainous island there are extensive areas that are too rough for cultivation, but which can be used for pasturage. The cattle ranches or stock farms

[20] Bigelow, John: Jamaica in 1850, p. 202 (1851).

[21] Compiled from official and semi-official sources.

are called *cattle pens,* and the rancher is called a *pen keeper.* The basic breed is the big-bodied Spanish longhorn, which has been acclimated throughout tropical America. Later the zebu or humped cow of India was introduced. This black-skinned animal is, like the negro, an adaptation to a tropical climate. Both the Spanish longhorn and the Indian zebu are practically immune to the cattle tick that carries Texas fever, and they are able, therefore, to thrive in the tropics. But both these breeds are inferior beef cattle and poor milk cattle when compared with the splendid animals that have been developed in Europe and the United States. Jamaican breeders have succeeded in crossing certain British cattle, which do poorly in the tropics, with the Spanish-Indian cattle, that are adapted to a hot climate, and thus securing fairly satisfactory beef and milk animals that can thrive in the tropics. In Jamaica, cattle raising is still an important and rather profitable industry. Ten of the leading pen keepers have upwards of 1,000 cattle each, and 65 keep 500 or more. The total is about 120,000 cattle. They are raised in all parts of the island (Fig. 4), but more especially in the west. Most of the beef animals are slaughtered and used in the island.

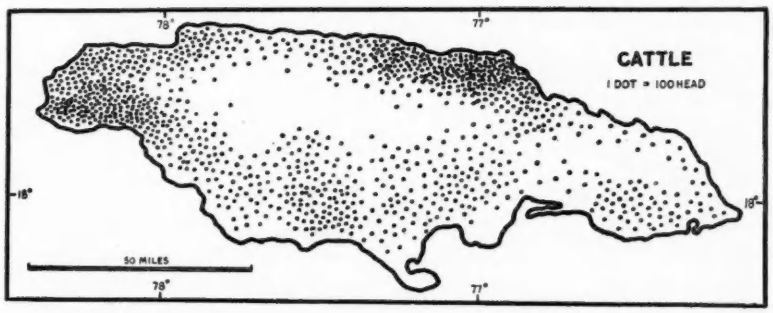

FIG. 4—The hilly character of much of Jamaica makes cattle grazing a suitable use for a third of the land. The ranches are called "cattle pens" and the ranchers are "pen keepers." The larger pens have a thousand or more cattle and the island has a total of 120,000 head. Beef cattle rather than dairy cattle predominate.

TRANSPORTATION

In a region so mountainous as Jamaica, the building of modern facilities for land transport is difficult and expensive. Some of the mountain roads of Jamaica are wonders of highway construc-

tion and they form a fine system, traversing nearly every part of the island. The main highways are macadamized and are graded to an easy slope that causes loaded trucks little or no difficulty. It is this system of excellent highways that permits small planters, even in remote sections, to market their bananas promptly and frequently, for the trucks of the banana companies or of the Producers Association systematically traverse these roads and gather up the fruit.

Railway lines reach from Kingston to Port Antonio and to Montego Bay, and include two spurs, giving a combined trackage of 222 miles. They, too, were very expensive to build, and the Government, which now owns them, incurs an annual deficit in their operation.

Because of the shipment of great quantities of bananas both to Europe and the United States, Jamaica has frequent steamship service. About ten ports ship bananas more or less regularly, but only two of the harbors (Kingston and Port Antonio) are deep enough for large ships to load at the piers. Elsewhere, ships must anchor some distance out and receive or discharge cargoes by means of lighters. Assuming 50,000 stems of bananas to be an average ship load, the 22,000,000 stems shipped from Jamaica in 1929 would fill 440 ships. Since many partial boat-loads are shipped, it is probable that upwards of 600 steamers a year carry cargoes of bananas from Jamaica.

COMMERCE IN AGRICULTURAL AND TREE PRODUCTS

Since nearly all of Jamaica's products are agricultural products or tree crops, the exports would be of a similar character. The following table shows the percentage of the total exports from Jamaica supplied by each of the leading products.

TABLE IV.—PERCENTAGE OF TOTAL EXPORTS OF JAMAICA, AVERAGE VALUE 1925-1929

Exports average about $24,000,000 *a year*

Commodity	*Percentage*	*Commodity*	*Percentage*
Bananas	45[22]	Coconuts and copra	5
Sugar	16[23]	Logwood extract	4
Coffee	7	Cacao	3
Pimento	5	Rum	2
		Miscellaneous	13

About one-third of the export and import trade of Jamaica is with the United States.

[22] 50% in 1929.
[23] 11% in 1929.

SUMMARY

Like most regions, Jamaica has both its geographical assets and its liabilities. In point of size it is large enough to afford considerable diversity of climate, soil, and relief, yet too small to provide a home market for a very large fraction of its major products. It is thus dependent upon outside markets to whose tariff laws and other policies it must submit. It is so mountainous that only about 10% of its land is under cultivation, yet the high lands provide sites for homes or resorts needed by the white residents and visitors. The widespread limestone rocks dissolve and erode into an angular and difficult topography, yet they yield a soil of remarkable endurance and fertility. The absence of ores and the depletion of the accessible timber lands leave the soil as the only important natural resource, and agriculture (including pen keeping) as the all-important industry. Its tropical location gives it abundant heat and, in most parts, ample rainfall, although droughts are not infrequent and tropical hurricanes at times spread ruin in their wake. Its ability to yield tropical crops desired in the British Isles, especially sugar, early attracted a white planter and professional population, but also made negro slavery profitable and has ultimately led to a 60-to-1 present ratio of negroes to whites. In spite of the abounding prosperity that occasionally prevailed in Jamaica, depression and discontent have been much more prevalent. The present success of banana growing by thousands of peasant farmers and by large proprietors makes Jamaica more prosperous than any other West Indian island except possibly Trinidad. With the exception of sugar, most of the export products are tree crops.

ROBERT DeCOURCY WARD, 1867-1931

The College Life of Robert DeCourcy Ward

W. M. DAVIS

As I look back on Ward's career at Harvard, exceptional competence in his studies and faithful devotion to his manifold tasks stand forth as his leading characteristics. He was a most conscientious worker; so conscientious, indeed, that his work endangered his health; he was too unselfish to care for himself as he should have done.

Robert DeCourcy Ward was born in Boston, November 29, 1867, the son of Henry Veasey and Anna Saltonstall (Merrill) Ward. His father had spent many years in business in Valparaiso, and had thus become so well known to the Chileans that he was appointed their consul at the Court of Saxony about the time of his son's birth. Hence, when Robert was six months old he was taken to Dresden, where four years were spent. A year in Lausanne, Switzerland, followed, and there his father died. His mother then, after a sojourn in England, brought him back to Boston, where he was at school for six years. Two more years were next passed at Dresden, and a good command of German was thus secured. Returning once more to Boston, he gave four years, 1881-1885, to school before entering Harvard College in the class of 1889. His first summer vacation included a voyage to Madeira and the Azores on a sailing vessel, and he thus gained some practical acquaintance with the ocean and with the art of navigation.

Not until his third year in college did young Ward enter upon subjects of study that he had not sampled in his preparatory school. My course in Meteorology was one of his ventures at that time and, apparently to his surprise, he enjoyed it. My first clear memory of him touches a question he asked regarding tropical hurricanes, which had been explained as depending on the deflective force of the earth's rotation for the spiral course of their inflowing winds. He asked in effect, "If those hurricanes depend on that deflective force and the deflective force is proportional to the sine of the latitude, how can the hurricanes occur on the equator where the deflective force must be zero?" I re-

plied, "That is a good question, and the answer to it is good also: hurricanes don't occur on the equator." From that time on, Ward stood out among his classmates and my long and closely personal acquaintance with him then began.

The following year he extended the beginning he had made in the introductory course on meteorology by taking up special problems, among which were, then and later, the reduction of observations on thunder storms and sea breezes that had been made in preceding summers by volunteer observers of the New England Meteorological Society, a promising young organization that failed to reach maturity: the results of these studies are published in the Annals of the Harvard College Observatory. The young meteorologist seems to have found mental satisfaction in his painstaking and rather monotonous work; better still, he found therein a subject which he liked well enough to wish to carry it farther. So after attaining grade A in 17 of his 18 college courses and graduating *summa cum laude*, and then spending a year abroad with two of his classmates, when he visited Germany, Italy and Greece, he returned to Harvard in the autumn of 1890 and accepted, much to my gratification, the position of assistant in my two half-year courses on Meteorology and Physical Geography. Thereafter his home was in Cambridge.

After taking an M.A. in 1893 and editing the American Meteorological Journal from 1892 to 1896, he was put in charge of the half-course on Meteorology in 1895 as instructor in that subject. He soon became a proficient and attractive teacher, and won the respect of both his Harvard and his Radcliffe students by his devotion to them and to his science. As he cared less for the mathematical and physical problems of meteorology than for the more human subject of climatology, he was appointed instructor in the latter subject in 1896, in which he soon became a master and a leader. It was in 1897 that he married Miss Emma Lane of St Louis and made with her a wedding voyage around South America. He visited that southern continent again in 1908 and 1910, and made a tour around the world in 1929; all these voyages were faithfully utilized as opportunities for gaining personal acquaintance with the climates of the regions he traversed. He was promoted to an assistant professorship in 1900 and to a professorship of climatology in 1910, a position which he held till his death.

During these years of teaching and authorship Ward became

also a trusted Harvard executive. He took his turn as chairman of the department of Geology and Geography from 1898 to 1904 and from 1907 to 1912, and was thus brought into increasingly close relations with his departmental colleagues on one side and with the College Office on the other. But his service to the latter had begun earlier, for since 1899 he has been practically a perpetual member of the College Administrative Board, his 32-year service there, always with close attention to the many and onerous duties thus laid upon him, having been longer than that of any other member of the College Faculty. In 1925 he became chairman of the Board of Freshman Advisers, and in 1926 a member of the Committee on Admission to Harvard College; and he gave an immense amount of thoughtful time to the work thus called for. In 1927 he was visiting professor to three western colleges, Beloit, Knox and Colorado, where his lectures made an excellent impression. His insufficient strength compelled him to decline three highly honorable appointments in recent years: Associate in one of the new Houses, Master of another, and Dean of Harvard College. From all this it may be perceived that he stood high in the esteem of his colleagues and of the Harvard Corporation.

Ward was one of the original members of our Association of American Geographers and its president in 1917; also of the American Meteorological Society and its president in 1920. He was a member of the American Academy of Arts and Sciences of Boston and of the American Philosophical Society of Philadelphia, and a Fellow of the Royal Meteorological Society of London. He was greatly interested in eugenics and was associated with the Cold Spring Biological Station of the Carnegie Institution of Washington as consultant on that subject. For the last twelve years of his life he was chairman of the Social Service Committee of the Cambridge Hospital, and for a number of years he was on the Committee of the St. John's Chapel of the Episcopal Theological School in Cambridge.

It may surprise some of our members to know that, in addition to the overflowing measure of life work above outlined, Ward developed another interest that grew to be of far-reaching, national, even international importance. While still an undergraduate he took up the problem of immigration from European countries into the United States and in 1894 founded, in association with Prescott F. Hall of Brookline, Mass., the Immigration Restriction League of Boston. He was president of it for

several years, his knowledge of its problems was authoritative, and in connection with its objects he made many visits to New York to examine the condition of arriving immigrants, and to Washington in connection with restrictive legislation. Our present quota laws are a direct outcome of the hard and persistent work given to this subject by Ward and his associates, few of whom were as active or as effective as he was. Verily, his climatological right hand did not know what his immigrational left hand was doing!

Robert DeCourcy Ward may be regarded as having realized, in his busy, well-rounded life, the ideal of what a college professor should be. He mastered the broad subject entrusted to him, presented it clearly and attractively to his students, made it widely known by his writings, and represented it worthily among his colleagues all over the world. He won the confidence of his associates and was therefore given an unusually active part in arduous administrative tasks, on the wise performance of which the life of a college so largely depends. His chief avocation was not only broadening to himself but of great value to his country, and was so well conducted that a high reputation might be based on it alone. His minor activities reflected his interest in and his responsibiliy to his community. Moreover, in all his relations he was a man of the world in the best sense of that phrase; he had a most attractive personality, he was a genial and sought-for companion, a courteous and delightful host. He cultivated a wide acquaintance but was careful, even fastidious, in making intimate friendships. Best of all, his was one of the happiest homes in Cambridge, and there, upon his wife and children, falls heaviest the grief we all feel in his too early death.

Robert DeCourcy Ward, Climatologist[1]

CHARLES F. BROOKS

With the sudden death of Professor Robert DeCourcy Ward November 12, 1931, the career of one of Harvard's most distinguished professors and America's leading climatologist came to an end. He was a master in teaching, investigation, writing and administrative work. Modestly underrating his own capacities, he strove always to make up for his assumed deficiencies by endless labor. The result was an extraordinarily productive and influential life, even though it was cut short just before his 64th birthday.

Professor Ward was an American pioneer in climatology. Others before him had explored American climates, established stations and summarized the observations. None, however, had taken this field for his life's work or sought to develop climatology as a science in the United States. In biographical notes, written in April 1930, Professor Ward states: "It was inevitable that, in a new field (the writer held the first professorship in Climatology in the United States, and one of but two or three such positions in the world at that time), the obvious work was to advance the science by setting forth its essential principles, in a way that would stimulate teaching. Therefore, it inevitably came about that most of the writing was in the nature of summarizing, in simple terms, what had been done by others. Often said to students: 'It has been my chief job to make simple what others have made involved.' A compiler of the best work of others, rather than an original investigator. This militated against recognition in higher scientific circles, but it was work that needed to be done, and which stimulated climatological teaching in this country."

No fair appraiser of Professor Ward's work could agree with him that he had not also made a notable contribution to the science of climatology. His early studies of the sea breeze and local thunderstorms, while he was a graduate student under Professor

[1]Memoir read at the Ypsilanti Meeting of the Association. In his remarks Prof. Brooks incorporated most of the tribute of Prof. W. M. Davis, which is published on pages 29-32 of this issue under the caption, "The College Life of Robert DeCourcy Ward."

Davis, are classic and still stand alone as investigations of these interesting and important summer phenomena in New England. Outstanding was his humanization of climatology, especially his insistence that climates be described not only in terms of temperature, rainfall, and the other separate elements, but also in terms of the weather ensemble. It is the weather from day to day, from one storm period to the next, that constitutes climate.

Professor Ward's book, "The Climates of the United States," is a contribution to climatology which will be standard for many years to come. This book contains the results of original research on the part of Professor Ward and numerous graduate students. With characteristic foresight, he planned this book fifteen or more years before it was published. He noted the gaps in American climatology and proceeded to fill them himself or by suggesting appropriate topics to his graduate students. These studies were usually brought to such a successful completion, thanks to his high standards, that editors were glad to publish them. Then these numerous published papers, along with investigations by the United States Weather Bureau, which also showed his influence, formed a solid foundation on which he could build his discussion of the climates of the United States. The book is admirably written, clear, concise, understandable by anyone, whether trained in climatology or not. Yet the advanced student finds in it the scholarly accuracy and ample bibliography that he needs.

Not long after "The Climates of the United States" was published (in 1925) a request came from Europe's veteran climatologist, Dr. W. Köppen, and his associate Dr. R. Geiger, for Professor Ward's collaboration in a new "Handbuch der Klimatologie" in five volumes. Ward was asked to undertake the preparation of 336 pages of text, tables and maps on the climatology of North America, a stupendous task. In spite of a heavy overload of administrative work at this time, he felt that he must coöperate in so eminently worth while a project. But he could do so only if he could obtain active assistance from the official weather services of North America and the collaboration of other investigators. He believed he could write the text if others supplied the tables and maps. This he did, and supervised the project during the next four years, finally finishing his last bit of text a month before his death. His collaboration in this project brought him further international recognition, and he was appointed a

member of the new International Climatological Commission of the International Meteorological Organization. But he stayed at home and worked on the Köppen-Geiger project and started his several classes instead of attending the first meeting of the Commission in Innsbruck last fall.

It is a noteworthy tribute to Professor Ward's ability and care in writing that all four of his books are still the leaders in their respective portions of the field. And his recently completed contribution to the "Handbuch" bids fair to serve as the standard on North American climate for many years to come. His first book, "Practical Exercises in Elementary Meteorology" (1899), led the way and is still the standby for teachers in elementary meteorology who are so fortunate as to have a copy available, it is out of print. Next, his translation of the first (general climatology) volume of Hann's "Handbuch der Klimatologie" (1903), a time-consuming and expensive labor of love, not only provided a comprehensive textbook for American students, but brought the best of European climatology to the United States. This book greatly stimulated and improved climatological research in the U. S. Weather Bureau. In spite of the fact that the publishers thought so little of the probable market as to require the author to pay several hundred dollars to bring out this book, it soon went out of print. It is now a rare work, but is still the only thorough text in English on this important subject. Three years ago he had begun writing a "Principles of Climatology" to replace it. Unfortunately, other duties so crowded upon his time that this book was scarcely one-third done at the time of his death.

As a companion volume to the Hann, Ward wrote a book, "Climate, Considered Especially in Relation to Man," which appeared in 1908. This volume contains a brief summary of general climatology and then detailed discussions of classifications of climate, the climates of the zones, hygiene of the zones, and changes of climate. This book was both a reader and a textbook which, since the Hann translation went out of print, has been the standard text for college courses in elementary climatology throughout the United States. A second, slightly revised edition, was published in 1918, and such was the demand for this book that a third edition was being considered.

Professor Ward was an editor in various capacities for forty years; first, of the excellent, though ill-fated, *American Meteoro-*

logical Journal, 1892-1896, then editor of "Current Notes on Meteorology (and Climatology)," 721 separate topics in 166 issues of *Science,* 1896-1908. Under the headings, "Notes on Meteorology," "Notes on Climatology," or in separate items, Professor Ward was a steady contributor to the *Bulletin of the American Geographical Society* and its successor, the *Geographical Review,* from 1899 to the time of his death. Skilled in reading foreign languages and in writing clear English, he performed invaluable service to American geographers by placing before them summaries or reviews of all he considered important in the American and foreign literature of meteorology and climatology. From 1899 to 1931 no less than 673 of such notes and reviews, ranging in length from several lines to three pages, were published in the *Bulletin* and *The Review.* The readers of nine other geographical journals, two of them foreign, also had the benefit of his writings. For five years Ward contributed reviews of American publications on meteorology to *Annales de Géographie.* The *Journal of School Geography* and its successor the *Journal of Geography,* of which he was associate editor, published 32 articles, reviews and notes from Ward's pen. He also contributed to "The American Year Book" and to the 11th to 14th editions of the "Encyclopaedia Britannica."

In 1927 Professor Ward was exchange professor to western colleges for one semester, and in 1928 was invited to carry his message to the public through the medium of the Lowell Lectures. This he did in wonderful form. His lectures were on "Man and His Climate" and though he discussed what he called elementary climatology it was the presentation of the master climatologist and lecturer. Each lecture lasted 60 minutes, to the dot, yet there was no hurrying, no lack of balance, no curtailment of the orderly summary at the end. How did he do it? Simply by rehearsing each lecture by himself "ten times" and marking on his manuscript a time-table that would bring him to the end at the right moment, and also sentences or paragraphs that could be omitted if he got behind schedule. Most of these lectures have since been published. Outstanding is his scholarly discussion of "The Acclimatization of the White Race in the Tropics." Published first in the *New England Journal of Medicine,* it was considered so valuable that it was reprinted in an *Annual Report of the Smithsonian Institution.*

Ward was a great believer in "field work." He "felt that a teacher of climatology, to understand his subject, must travel and

have personal experience with various types of weather and climate. He planned to write a 'Guide Book to the World's Weather and Climates,' to give the essential characteristics of atmospheric conditions, and to call attention to interesting weather or climatic phenomena which a traveller should look for in different parts of the world. The idea was that unique features of this sort are just as well worth looking for, and studying, as are famous glaciers, or waterfalls, or pictures, or cathedrals."

In 1912 as a member of the Transcontinental Excursion of the American Geographical Society he made the most of his opportunities to observe the interesting contrasts in climates and their effects to be seen in the United States. How pleased he was to swelter in cool San Francisco and to be delayed by heavy rains in the Arizona deserts! Climatic curiosities to be found at certain places and seasons appealed to him as worthy of listing in a guide book to the world's climates. In a lecture before the American Philosophical Society in 1928 he developed this theme in a delightful manner and presented the Mediterranean region as a sample. The following year, in a trip around the world, he had an opportunity to add further to his guide-book ideas. He wrote as he went, and stepped ashore at New York with "A Climatologist's Round-the-World Voyage" and "Thirty Thousand Miles of Barograph Curves," ready to publish. His last trip was a leisurely one through the lesser Antilles last summer. But perhaps it should not be called leisurely, for again he accomplished the impossible and stepped down the gangplank at Boston with a full and finished account of his journey!

With Professor Ward, "teaching was a passion." He always endeavored "to make lectures thoroughly up-to-date, clean-cut, logical, interesting. Infinite pains were taken with the revision of all lectures. Seldom was any lecture given just as it had been given before. Such constant revision necessitated an enormous expenditure of time, and left but little leisure for writing." However, the list of his published articles numbers over 325, not counting several times as many short notes, reviews, etc.!

In closing, it is appropriate to summarize Ward's service to geography. He put climatology into American geography; by teaching it to thousands of students and teachers over a period of 41 years; by making investigations and encouraging others to do so on a systematic plan; by publishing in geographic and general scientific journals summaries and critical reviews of what he

considered the best in foreign and domestic climatological literature—perhaps 2,000 items altogether, a prodigious total; by writing and widely distributing interesting and scholarly books, articles and longer reviews on general and regional climatology and closely related topics—263 in 101 different publications; by emphasizing and demonstrating the value of climatological field work; and by lecturing, especially by bringing his clear-cut message to geographers' meetings. His paper on "The Literature of Climatology" at the last meeting was a fitting finale. We cannot forget "his engaging personality, the sparkle in his eye, his quick reactions in social intercourse, his sprightly, brisk manner of speech, the humor and wisdom of his conversation."

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ISAIAH BOWMAN.

Pioneer Settlement. (Presidential Address. To be published in full in a later issue.)

ROLLIN S. ATWOOD (Introduced by Wallace W. Atwood).

Population Changes in Florida from 1920 *to* 1930.

The substantial settlement of Florida started after 1875, which date marked the beginnings of agricultural production for export. The increase in population since that time has gone forward with leaps and bounds reaching a grand total of nearly a million and a half in 1930. From 1870 the decennial increase in population has been the highest of any state east of the Mississippi river, except during the decade from 1910 to 1920, when the increase in Michigan was 1.7 per cent greater than in Florida. Between 1920 and 1930 Florida ranked second only to California in percentage increase in the entire United States. The five leading states during this period were: California 65.7%, Florida 51.4%, Michigan 32%, Arizona 30.3%, and New Jersey 28.1%. The tremendous growth during this last decade has brought with it astounding changes in the occupations of the people of Florida and has changed the entire complexion of the state. A half a million permanent residents were added to the population between the years 1920 and 1930. Where are they—what are their occupations—and what factors have been most significant in influencing their distribution, life and work?

WALLACE R. ATWOOD (Introduced by Wallace W. Atwood).

New Light on the Physiographic History of Mount Mazama, Crater Lake National Park.

As early as 1902 Joseph S. Diller wrote of glacial valleys and striated surfaces on the rim encircling Crater Lake. The evidences of ice action which he saw on the slopes of Mount Mazama, dated to the last glacial advance in the region. Studies during the past summer indicate that there were three, and probably many more such advances in the course of the mountains' growth, and each one was followed by a period of volcanic activity, when lava and

fragmental material covered the mountain slopes and much of the surrounding region. The alternation of glacial debris and volcanic ejectamenta tell a story of volcano building which emphasizes the time factor in earth history.

At two localities inside the rim, which encircles Crater Lake, charred plant remains were found buried beneath volcanic pumice and lavas. In much the same manner as alternating layers of glacial and volcanic material indicate great time intervals in earth history, so do these charred vegetal remains, buried in volcanic material, point to long periods of time during which soil was formed, plants took hold, and a flourishing vegetation covered the slopes of the volcano. Volcanism, glaciation and the invasion of vegetation have played important rôles in the growth of Mount Mazama.

WALLACE W. ATWOOD.

Correlation Studies in Regional Physiography.

The sequence of events in the physiographic history of one region may be quite different from the order of events in the physiographic changes of a neighboring area. There must be some relationship between the geomorphic changes which are taking place in adjoining regions. Stream erosion produced in time the Rocky Mountain peneplain and while that work of reduction and removal of rock material was in progress, vast quantities of loose material accumulated on the neighboring Great Plains. One mountain region may be affected by uplifting or arching and another, not far distant, may be buried under vast accumulations of volcanic debris. The summit peneplain of the San Juan Mountains was uplifted in the central and western portion of the area and it now stands at about 12,000 feet above the sea, while at the east it was depressed until it came to be hundreds of feet below the surface level in the San Luis Valley. What was going on in the Rocky Mountains when the Colorado Canyon was being excavated? What was going on in the Great Basin while the Sierra Nevada block was being uplifted? How did the uplift of the Sierras influence changes in the Great Basin?

The period when the fundamental principles of physiography were being worked out has passed. Most of the papers presented today by students of physiography in this country and at the international congresses of geographers are the results of regional studies in which the principles of physiography have been

carefully applied. Is there not an important field of investigation and one that is exceedingly attractive to the youth of today in the correlation of regional studies involving the sequence of physiographic events in neighboring regions?

O. E. BAKER.

Regional Shifts in Land Utilization as Shown by the 1930 *Census.*

In 1929 the area in crops, about 360,000,000 acres, was practically the same as in 1919, whereas population had increased nearly 17% and agricultural production about 19%. But this more or less stationary acreage was the result of a decrease of over 32,000,000 acres of crops in counties reporting a decrease, located mostly east of the Mississippi River, and an increase of 33,000,000 acres in counties reporting an increase, located mostly west of that river, principally in the Great Plains region.

Both the stationary crop acreage in the nation as a whole and the vast regional shift in acreage was largely a result of the widespread use of the automobile and tractor. The decline of about 9,000,000 in number of horses and mules since 1919 (to date) has released fully 25,000,000 acres of land, which has been used principally for the production of meat, milk and cotton. By greatly reducing the cost of producing wheat in the West, the tractor and combine also have promoted indirectly a shift from wheat to corn and other crops in the East, and, in turn, from corn to cotton in the South. Hogs accordingly have decreased greatly in the South and increased in the North, particularly the Northwest, where the animals are of higher grade and much more efficient in transforming feed into human food. Dairy production also has greatly increased in the North, despite a stationary number of cows. The increased efficiency of farm animals in utilizing feed from these and other causes has resulted in an economy of, perhaps, 25,000,000 acres more of crop land.

Partly because of these shifts from grazing to grain in the Great Plains, from small grain toward the higher yielding corn crop in the Corn Belt, with more hogs and cows and poultry, and from corn toward the more productive cotton in the South, and partly because of great improvements in agricultural technique, an extraordinary increase of production occurred between 1921 and 1926-1928, followed by low prices, which has accelerated the recession of agriculture from the hill lands, the eroding lands and

the inherently poor lands. How to help these areas of declining agriculture has become a great national problem.

The rapid decline in both births and immigrants during the decade, and the approach of a stationary and possibly declining population later, indicates that this problem of submarginal land is almost certain to be permanent and not transitory. Agricultural recession in half of the nation, accompanied by severe soil erosion in some and of serious social problems in all of the declining districts, raises issues many of which are beyond the power of the individual to solve. There is need for a new national land policy. The welfare of the nation as well as of agriculture requires it.

R. L. BELKNAP (Introduced by K. C. McMurry).
Processes Associated with Glaciation.

Several theories have been presented to account for the peculiar physiographic form, the "tind." The author, while failing to find a typically cone-shaped "tind" during his studies in Norway, did study some of the mountains described as such and found they were quite similar to the horn; they could be accounted for by cirque recession combined with the erosive action attributed to outlet glaciers. In many cases rugged topographic effects due to glaciation had been maintained or even accentuated by wave action.

Both in Norway and Switzerland there was a paucity of evidence pointing to the effectiveness of frost action in connection with bergschrund action. There were certain indications that other processes as agents associated with glaciers—thaw water and avalanches especially—had played an important rôle in the development of the topographic forms associated with glaciers and glaciation.

CLAUDE H. BIRDSEYE.
Aerial Stereo-Photographic Mapping.

The introduction of this paper outlines the differences in methods between ground survey and aerial photographic operations in topographic mapping. This is followed by references to and analysis of the principles of perspective and parallax which one must comprehend in order to understand stereoscopic measuring and plotting. The relation of ground control to aerial mapping is cited, principally because there have been so many misstatements made which have led some readers to think that all one needs

is a set of aerial photographs and a complete map is immediately forthcoming.

The author describes the different types of aerial cameras used in stereoscopic mapping and illustrates the most commonly used foreign and domestic instruments.

The author omits entirely any description of simple stereoscopes and confines his discussion to what are known as "automatic" measuring and plotting instruments. In describing these he gives the general details of the best known American and European instruments and then gives a detailed description of the construction and operation of the Hugershoff Aerocartograph and Aerosimplex which are the instruments which he has been using.

The author concludes his paper with a plea for the development of American made instruments which will be more adaptable to our small scale mapping problems and the availability of which would eliminate the payment of high duty rates.

S. W. Boggs.

Boundary Functions and the Principles of Boundary-making.

Studies of the principles of boundary making have hitherto been confined, unfortunately, almost wholly to international boundaries. Furthermore, they have usually been made on the false assumption that the functions of boundaries are uniform and static.

A scientific geographical study of boundaries should take into consideration all types of political boundaries—international boundaries, and both major and minor boundaries between administrative divisions within a country. The functions which each political or administrative type of boundary serves should be classified, and each group of functions should be studied in relation to the various types, as illustrated by past as well as present boundaries. On the principle that a good boundary is one which serves the purposes for which it is designed, with a maximum of efficiency and a minimum of friction, the results of such a study should reveal that for a given set of functions or purposes a boundary which satisfies a given set of geographic conditions is desirable, while for another set of functions another geographic type of boundary is desirable. Instead of attempting to lay down general principles that should govern in respect of all boundaries, therefore, principles should be formulated with reference to the adaptation of different types of geographic boundaries to different sets of boundary functions.

A study of treaties and agreements, laws, duties of boundary officers, and of boundary incidents, constitutes an essential part of a thorough study of boundaries and boundary functions.

The functions of internal boundaries, such as those between the states of the United States, have undergone change within recent decades and may be expected to continue to change. Similarly the functions of international boundaries have undergone considerable change in recent centuries, and will continue to change, and at any time they vary from place to place. There is no clear-cut line of division between the functions of international and internal boundaries.

It is the tendency to assign the rôle of water-tight-compartment functions to international boundaries, as distinguished from inter-provincial boundaries, that makes the former such trouble-makers. It is found, however, that in some instances boundary problems which cause friction and endanger peace may be solved better by a revision of the functions which are assigned to them than by modifications of the boundaries themselves. Recent revisions of boundary functions are cited as an indication of the beginning of a realization of this fact.

To take account of varying boundary functions greatly complicates the study of the principles of boundary-making. But it makes the study at once more practical, in that it takes account of all relevant facts in a scientific manner.

ALBERT PERRY BRIGHAM.

Research by American Geographers Since 1900.

An American geographer's disparaging remark about the progress of research has led to the offering of this paper. There is some need for preliminary reference to the scope of geography and the meaning of research, if we deal understandingly with this theme. We accept the broader definition of geography, and we recognize in research, all grades of originality, exactitude and fullness of treatment. In the Nineteenth Century, studies in mature geography were mainly incidental to inquiries in other fields.

We here consider what has been done in advanced studies by Geographical Societies, by corporate action or through stimulus to their members. Here are numbered our own Association, the American Geographical Society, the National Geographic Society, and to a lesser degree other societies with more limited resources.

We take account of the University Departments and Schools of Geography, with a review of the themes of doctoral dissertations accepted during thirty years. Further, the geographic studies carried on by departments of the Federal government, and State governments, very many of these receiving direction or large contributions from the members of this Association. Much of our research has been experimental and fragmentary. This was inevitable in a newly developing subject in a new and vast country. No attempt at monographs of large scope and great profundity could have been so valuable as what has been done. We have been assembling materials and trying out methods for the more intensive and rounded work of the future. Reference is made to facilities for research offered through the Division of Geology and Geography of the National Research Council. Grants in aid may be sought, for important studies to be made by experienced geographers.

ALBERT PERRY BRIGHAM.
Washington's Journeys in New York.

This paper grows out of a contribution made by the writer to the George Washington Memorial Atlas, edited by Col. Lawrence Martin. In 1783, in New York, Washington made his farthest north and made also two of his three visits to the fringe of the Laurentian basin. Washington was in military command; was a landowner on a vast scale; he was a great farmer; was deeply interested in interior navigation, and he was a statesman intent on opening the West and joining it to the East. All these motives had place in his journeys in New York.

M. R. CAMPBELL
A Composite Peneplain.

A composite peneplain, as indicated by its name, is one that is not simple in its mode of formation or in its surface features, but is the result of a number of cycles or partial cycles of erosion which are separated by such slight uplifts that the forms of one cycle merge with the forms of the preceding cycle and also with those of the cycle following. A composite peneplain will be formed only near or upon the fulcrum upon which warping hinges, but it may extend for a considerable distance in the direction of the axis of the anticlinal uplifts.

The best example of a peneplain of this character, with which

the writer is acquainted, is that developed in the Piedmont province of the Appalachians, south of Washington. This is described and its peculiar surface features, which have never been explained, will be shown to be the direct result of the formation of such a peneplain as that described above.

PHIL E. CHURCH (Introduced by Charles F. Brooks).

Surface Temperatures of the Temperate North Atlantic West of the 60th Meridian.

From south to north six sub-areas are distinct: (1) a moderately warm area around Bermuda, (2) the Gulf Stream, (3) the "cold wall," bordering the northern edge of the Gulf Stream, (4) a narrow upwelling zone along the northern edge of the "cold wall," (5) a cool area between the upwelling zone and the coastal water and, (6) the coastal water over the continental shelf.

The area around Bermuda, though it lies in lower latitudes, is cooler than the Gulf Sream. This cooler temperature is ascribable to the slow drift of incoming warmer tropical water. The annual temperature range is 17° F., from 65° F. in March to 82° F. in September.

The Gulf Stream, at the northern edge of this moderately warm area, gradually spreads, from a mean width of about 50 miles in the latitude of Cape Hatteras, to one of about 70 miles at the 65th meridian. At intervals of several weeks temporary offshoots of this tropical water debauch into the cool area of the north. In summer there is a slight northward shift of the warmest water which amounts to about 15 miles off Cape Hatteras and 35 miles near 65° W. Long. The mean annual range of the maximum temperature of the Gulf Stream near Cape Hatteras is about 11° F., from 74° F. to 85° F., while 650 miles farther east the range is 13° F., being from 69° F. to 82° F.

At the northern edge of the Gulf Stream the temperature usually falls so markedly in a short distance that this transition zone has been named the "cold wall." A drop of between 18° F. and 30° F. is characteristic in late winter; however, this dwindles to only 2° F. to 6° F. in the late summer.

A narrow band of distinctly low temperature, a mile or two in width, is found at the northern edge of the abrupt transition zone during all months except August. Temperatures of this band are lower than those on either side and often are not matched

by those within 100 miles. The only source of this cool water is obviously from below. Therefore, this has been called the upwelling zone.

The cool area, north of the upwelling zone, is characterized by a heterogeneous thermal distribution due to extended masses of warmer tropical water which have been drifting about for longer or shorter periods. These masses gradually cool by the combined effect of time and mixing.

The coastal water is subject to large changes within a short period, due, primarily, to its exposure to the cold northwest continental winds in winter and the warm southwest winds in summer. These factors, plus others, combine to produce here an annual range of nearly 40° F.

GEORGE B. CRESSEY (Introduced by W. W. Atwood).

Why Shanghai?

Metropolitan Shanghai has a population of 3,250,257, and is thus the fifth largest city in the world. Less than a century ago Shanghai was an inconspicuous fishing village, yet today it is the outstanding city on the Asiatic mainland.

The growth of Shanghai is a continuous record of overcoming obstacles. The site of the city is a tidal flat bordering the shallow and winding Whangpoo River. The environs contain neither minerals, fuel, water power, wood, or stone. In addition, political problems in the foreign areas and civil chaos in the interior have complicated the city's development.

Why, then, has Shanghai grown? In the first place, few cities have so large and potentially rich a hinterland. Shanghai is the one natural outlet for the Yangtze valley, which has an area of 750,000 square miles and a population of 200,000,000, one-tenth of the human race. Second, the Yangtze delta has a dense population and is the principal cotton and silk producing area of China. In the third place, while the natural resources of eastern China are unimportant, valuable deposits of iron ore, coal, antimony, tungsten, and other minerals are found in central and western China. Fourth, in addition to its location at the mouth of China's greatest river, Shanghai occupies a central position between the north and the south, thus making it an important trans-shipment point for international trade. Fifth, it is the nearest port to Japan and lies on the two main steamship routes of the western Pacific, one to North America and the other to Europe. Finally,

a considerable part of the credit for Shanghai's growth must be given to foreign initiative which has aided the development of trade and industry and has made the international areas of Shanghai a haven of refuge during periods of disorder in the interior. In a cultural as well as a commercial sense, Shanghai is the chief gateway to China, and through it pass many of the ideas which are transforming the nation. Accessibility to the outside world and a strategic location in China have thus been large factors in the growth of Shanghai.

With the establisment of peace and adequate transportation facilities throughout China, it seems reasonable to expect that the growth of Shanghai will make it in point of importance as well as in mere numbers one of the outstanding cities of the world.

COLLIER COBB.

Present Uses of Eolian Sands and Loessal Soils in the Mississippi Basin.

The striking feature of such soils, whether they are derived from rock flour ground by the glacier, or produced by alternations of heat and cold from day to night in regions of little rain, is that the mineral components of the soils have suffered little, if any, chemical decay, their minerals being recognized by the microscope.

These constitute the best wheat lands the world over; but along the length of the Mississippi and most of its tributaries they are now used for extensive truck farming or are devoted to dairying industries.

SAMUEL N. DICKEN (Introduced by Ralph H. Brown).

A Dry Farming Area in the San Joaquin Valley, California.

Dry farming, usually limited to regions having from 12-20 inches mean annual precipitation, is practiced on the west side of the San Joaquin Valley, with less than ten inches. This area extends as a narrow strip of land four miles wide and sixty miles long from Tracy to Los Banos. The precipitation has a decided cool season maximum and the crops, grains and hay grains, are winter crops. With any other distribution of precipitation dry farming would be unsuccessful; even here a system of "summer fallowing" is considered necessary to maintain soil moisture, and in the more arid parts of the region the land is cultivated only once in from three to five years. In spite of the low rainfall values, ranging

from 7-11 inches for the annual mean, the climate is of the steppe type. The methods of cultivation, especially summer fallowing and the use of heavy machinery, require large holdings, the farm units averaging about 1,000 acres.

R. E. DICKINSON (Introduced by C. C. Colby).

Some New Features of the Growth and Distribution of Population in England and Wales.

The twentieth century ushers in a new phase in the growth and distribution of population in England and Wales, which is characterized by (a) the decreased rate of growth of the large cities with over two hundred and fifty thousand inhabitants; (b) the increased rate of growth of small towns (50,000 to 100,000), a number of which are located in southern England; (c) the increased growth of population in rural districts, almost equalling that of the urban districts from 1901 to 1921, and actually exceeding the latter in the 1921-1931 decade.

A clearer picture of the increase in urban population is obtained from a consideration of the six principal conurbations, which contain 40% of the total population. During the last decade, the very small percentage increase of Greater Manchester and West Yorkshire, characteristic of previous decades, is continued; but the most remarkable new features are the large increase of Greater London and the Home Counties, and Greater Birmingham (twice that of England and Wales), and the almost stationary population of Tyneside, which in previous decades recorded a very high increase.

The rural increase is found mainly in (1) areas peripheral to the large cities, and (2) areas of colliery development. The latter for the period 1901-1921 include Northeast England, the West Riding and Northeast Midlands, and South Wales. In the 1921-1931 decade, the population in rural districts in the first has actually decreased, and in the third, has received a check, while the aggregate population of its urban districts has decreased. The decreased rate of growth in these areas is due mainly to migration. In the truly rural areas the exodus of population still exists, though it passed its high-water mark at the close of the last century.

These phenomena are to be explained by a variety of factors. The very low birth rate accounts for the small increase of the textile conurbations, and the large birth rate for the high increase

of Tyneside. Since 1901 the conurbations have been losing population by migration to their peripheral semi-rural areas, and small towns, due to residential and industrial developments rendered possible by transport facilities and the extension of electricity supplies. During the last decade, the depression of the basic industries, and the relative prosperity of secondary light industries established in the Home Counties and the Midlands are reflected in (a) the decreased rate of growth of the northern conurbations—particularly Tyneside—and South Wales, and (b) the extremely large increase of Greater Birmingham and the Home Counties (including London), the last recording a gain of over 600,000 by migration.

STANLEY D. DODGE.

On Roads in Relation to the Economic Domain of an Urban Center.

The development of roads in the area about Princeton, Illinois, shows clearly what parts of that area are tributary to and what parts are not tributary to the central town. By an examination of the roads, the economic domain of Princeton is worked out.

LOYAL DURAND JR. (Introduced by R. H. Whitbeck).

The Geographic Regions of Wisconsin.

There are twenty-two geographic regions in Wisconsin. The delimitation of these units is the result of reconnoissance field work and of library work on the part of the writer.

Northern Wisconsin, the sparsely settled woodland and cut-over portion of the state, has been divided into five geographic regions. The Lake Superior Lowland lies along the shore of the lake. High escarpments separate it on the south from the interior northern highland of crystalline rocks. Four geographic units compose the highland. There are three sandy areas, the Northwestern Pine Barrens, the Northeastern Sand Region, and the Northern Lakes Country. Within the latter region there is a decided concentration of inland lakes, and marked recreational use of the land. The greatest area of the northern highland is included within the Northern Forest, Brush, Hay and Dairy Region.

Three geographic regions on the border of northern Wisconsin are well settled and developed. The Central Dairy Region lies on the part of the upland that is covered by old drift, relic of a

pre-Wisconsin glacier. The Antigo Flats and the West Shawano Upland are regions small in area, yet with distinct cultural landscapes.

The sandy central portion of Wisconsin has been divided into two geographic regions, the Central Glaciated Sand Country on the east and the Central Sand Plains on the west. The two are separated by the terminal moraine of the Wisconsin glacier.

Within the glaciated southeastern portion of Wisconsin there are eight geographic regions. Two urban units stand out, the Fox-Winnebago Urban Belt and the Lake Shore Urban and Manufactural Belt. The Door Peninsula Fruit and Resort Region lies between Green Bay and Lake Michigan. Four separate regions combine to form the intensive dairying sections of Wisconsin. These are the Northeastern Dairy Region, the Eastern Lake Shore Red Clay Dairy Region, the Southeastern Dairy Region, and the Upper Rock River Valley Dairy Region. The Rock County Dairy-Corn Belt lies on the outwash plains and old drift beyond the border of the recent drift.

The western upland contains the most rugged and dissected land of the state. The West-Central Maturely Dissected Region of Valley Culture lies in the northern portion of the unglaciated section and the old drift areas just to its north. The rough central portion of the Driftless Area is included within the Western Maturely Dissection Region of Ridge and Valley Culture. South of Military Ridge is the Southwestern Maturely Dissected Region of Ridge Culture and Associated Valley Culture. The western upland is completed at the north by the Northwestern Dairy Region.

MARGARET IRENE FEAD (Introduced by Stanley D. Dodge).
The Development of the Cartographical Representation of Cities.

Two types of city maps have been developed, the perspective and the horizontal, of which the latter is the earlier. It was not until the late 16th century that the city plans became accurate in execution. By the early 19th century the perspective plan was discarded in favor of the horizontal. Two recent outgrowths of the horizontal plan are the morphological and functional ground plans.

WM. OSGOOD FIELD JR. (Introduced by Lawrence Martin).
The Glaciers of Northern Prince William Sound, Alaska, 1931.

The Glaciers of Northern Prince William Sound were carefully studied from 1899 to 1911 and the general behavior of the various glaciers was then determined, but since 1911 relatively little attention has been paid to them. The object of the 1931 expedition, therefore, was to observe the present condition of the ice fronts and to interpret as far as possible the events of the previous twenty years.

Ten large glaciers and a score of smaller ones were visited, including Valdez, Shoup, Columbia, and Meares Glaciers as well as the many ice streams of Harriman and College Fiords.

In general the ice fronts have retreated and the volume of ice has shrunk since the widespread advance which began about 1909 and continued for some years. There are two important exceptions, however, for the ice fronts of Harriman and Harvard Glaciers, the largest glaciers of Harriman and College Fiords respectively, now occupy more advanced positions than during the recent maximum, while surrounding them are smaller glaciers which have shown marked retreat and shrinkage since that advance, thus indicating that other factors besides climatic variation are to be considered.

Columbia Glacier offers one of the most attractive and interesting fields for glacial observation as it has been studied in great detail in the past and its seven mile terminus illustrates many principles of glacial phenomena. Also of particular interest is the behavior of its western moraines with respect to the two large embayments into which a portion of the ice stream is deflected, there to melt away in large enclosed basins whose drainage flows back out under the main course of the glacier.

Additional data was also obtained on the upper regions of the various glaciers and their relationships one to another as well as to the northward flowing ice streams of that part of the Chugach Range. There in places are to be found extensive snowfields sending large glaciers north and south, while in other localities the crest of the range is composed of a high and almost unbroken mountain ridge. Of these mountains little seems to be known. Various maps indicate different peaks with a confusing variety of names. The highest elevation, however, seems to be a 13,250-

foot snow peak on the north side of Harvard Glacier eleven miles from tidewater at the head of College Fiord. On each side of this peak, but mainly to the east is a complicated and rugged mountainous region with 9,000 to 12,000-foot peaks from whose slopes flow the great glaciers of Northern Prince William Sound, forming one of the most beautiful and least known of all the mountainous regions of Alaska.

J. SULLIVAN GIBSON (Introduced by W. W. Atwood).
Distribution of Tobacco Acreage in Kentucky.

The distribution of tobacco in Kentucky can be interpreted largely in terms of physiography and soils. In the rugged eastern sections where the soil is thin and infertile, both the total acreage of tobacco and the ratio of tobacco to other crop acreages are very small. In the less rugged central and western parts where fertile limestone soils are abundant, tobacco acreage becomes important. Contrary to general opinion, the ratio of tobacco acreage to total cultivated area is conspicuously small—only 22%—in the Lexington Plain region where the concentration of tobacco production attains its maximum.

If farm land value be accepted as a criterion of productive soils, the maximum land values in the Blue Grass region where also the maximum tobacco production is found substantiate the belief that fertile soil of high lime content determines in large part the cultivation of tobacco in Kentucky.

In the Blue Grass area in general and on the Lexington Plain in particular, cultivation of tobacco becomes most important. The fertile soil developed from the Ordovician limestone exposed in the Cincinnati dome is especially adapted to tobacco. Because of the high productivity and consequent high values of land in this area farmers give the soil excellent care and they obtain higher yields here than elsewhere in the state. The Burley air-cured variety which is superior to the dark fire-cured kind is grown here almost to the exclusion of other varieties.

A second tobacco area less pronounced than the Blue Grass region, is found in the Ohio Valley in the vicinity of Owensboro. Although the ratio of tobacco acreage to that of other crops in this region is somewhat lower than that of the Blue Grass area, the considerably higher percentage of total area cultivated in the Owensboro region tends to bring the tobacco density of this region almost up to that reached in the Blue Grass. Both river

alluvium and upland soils are used for tobacco in this area; the Burley and the dark fired varieties are both grown.

The southern tier of counties across the western half of the state comprises another area which constitutes a tobacco region. No sharp line can be drawn betwen this and the other two regions outlined above; but the zone of connection between them is restricted to relatively narrow width. This region includes part of the Pennyroyal Plateau and a section of the Mississippi Embayment extending southward into Tennessee, and constitutes one of the largest regions of dark tobacco in the United States. The higher value of Burley tobacco has induced its more extensive planting in recent years in this region, where in some sections its acreage is even greater than that of the dark variety.

ROBERT BURNETT HALL.

Settlement in the Yamato Basin.

The Yamato Basin is "the cradle of Japanese civilization." It has had a continuous settlement for many centuries and each historical change in Japanese life is reflected in the Yamato landscape. Little of the past has been given up but each new impress has been readily added. The basin has held a dense population since ancient times and there has been a great pressure on the land. There are few places in the world where man has so largely altered the fundament.

The settlement forms of the area were for centuries controlled by law and the dictates of the social system. Long ago population numbers reached a point of saturation, under the rice economy of "Old Japan." In consequence, there was a static settlement condition. Since the Restoration, there has been a rapid change. Economic rejuvenation has allowed an increase in population. The archaic restrictions, which retarded a more sensible occupation of the land, have been abolished and widespread changes in the distribution of population are taking place. The coming of new economies, of new ideas and of new materials is allowing radical changes in both village and habitation structure.

ROLAND M. HARPER.

Switzerland, the New England of Europe.

It has long been known that Switzerland resembles New England in having much rough topography, rather poor and rocky soils, few valuable minerals, many lakes, clear streams with abundant water-power, a cool bracing climate, and forests largely

coniferous. The form of government and size of political divisions are much the same in both, and both are popular summer resort regions.

There are also many resemblances in population and industries, which are not so generally realized. In both regions there is more manufacturing than farming, and the farms are rather small, with more pasture than plowed ground. Prof. Jefferson has pointed out that the Swiss lead Europe in inventiveness, as New England does the United States.

In both regions females have long been in the majority. The percentage of adults is high (60.1 in Switzerland, 62.0 in New England in 1920, as compared with 57.6 in the whole United States), and consequently birth rates are rather low. People marry later in Switzerland and New England than in other parts of the same continents, and have rather small families.

The rural population does not migrate much. There are no statistics of this sort for New England, but nearly half the inhabitants of Switzerland were born in the commune in which they live, and nearly three-fourths in the same canton. Changes in the composition of the population from one decade to another are slow.

WILLIAM H. HOBBS.

Wilkes Land Rediscovered.

In 1840 the United States Exploring Expedition under the command of Lieutenant Charles Wilkes penetrated into the Antarctic Region. On January 19 he discovered land and then skirted the coast of a continent which extended 1500 miles to the westward. At the same time a French Exploring Expedition under Captain Dumont D'Urville penetrated into the same general region and made a landfall somewhat farther to the westward on January 20, although in his log the date is given as January 19. This land is now known as Adélie Land.

Because the dates of D'Urville's log were all in error by one day, geographers have rather generally given priority to the French explorer in discovering Antarctic land, though he made no claim to having discovered a continent, and in the nature of the case could not have done so, since he so soon turned back.

Wilkes, on the contrary, cruised in a westward direction along the coast of a new continent, which he claimed as such and proved, not alone through a long series of landfalls lying near the Ant-

arctic Circle, but by soundings which revealed a continental shelf along its front, and by the study of rocks of continental type which he had taken from icebergs off the coast. By all save British and French explorers and geographers the sector of the continent which Wilkes discovered has been called Wilkes Land. The English explorers Ross and Borchgrevink claimed that they sailed over "Wilkes Land" and have striven to discredit Wilkes; yet no one of them, as can easily be shown, was ever over Wilkes Land at any time. None of them save Scott on his last expedition even approached it.

The first to enter the waters off Wilkes Land was Sir Douglas Mawson, nearly three quarters of a century after the Wilkes' discovery. Mawson on his expedition of 1911-14 did sail over some of the coast land represented on Wilkes' map. The importance of Mawson's discoveries on the land, led some geographers to question the existence of Wilkes Land. Mawson's new expeditions of 1930 and 1931 have now in a striking manner verified the existence of Wilkes Land, though they have shown that the coast as he represented it is rather generally too far to the northward. This is clearly accounted for by the great clarity of the atmosphere and the astounding visibility. Mawson himself in 1930 mapped the coast of his newly discovered MacRobertson Land within a sector of the Antarctic farther to the westward, only to sail in the succeeding season over hundreds of miles of his own coast which he had located some sixty to seventy miles too far to the northward. His three expeditions therefore, taken together, despite any claims to the contrary, have supplied a striking vindication of Wilkes, through a rediscovery of the greater part of Wilkes Land.

GEORGE D. HUBBARD.

House Locations in Norway Fiord Areas.

Man has chosen very restricted and special places for his homes in the fiord areas of Norway. Deltas and beaches of several levels, moraines, fans, talus slopes, mouths of low-hanging valleys and cirques, small floodplains, waterfalls and rapids seem to be the most frequent places taken. Intersections of highways play a small part in such house locations. Thousands of square miles in irregular areas have very few or no houses and some seemingly favorable sites are avoided. Occupations are examined to see if they are more influential than soil and other physiographic

factors in determining house locations. There probably will be but little change in the future in the kind of places chosen except in response to the growing tourist trade.

ELLSWORTH HUNTINGTON.

The Measurement and Geographical Distribution of Mental Activity.

Geography has made steady progress from the purely physical to the human aspects. Human geography has progressed steadily from the racial, economic, and political phases to the social, cultural, and intellectual phases. Thus there arises an urgent need for a sound undertaking of the relation between intellectual activity and the environmental background. In order to meet this need the author has searched for mental criteria which are capable of being expressed numerically and thus of being compared with the environment. Rossman and others have shown that the mental activity represented by applications for patents and by violent insanity follow nearly the same seasonal trend which the author found in the daily marks of students at West Point and Annapolis. The percentage of persons passing civil service examinations and the rise and fall of the stock market have now been investigated in similar fashion. The stock market data are not very clear, but civil service examinations in three different areas agree with the other lines of evidence. They indicate that mental activity is greatest at temperatures decidedly lower than the optimum for physical activity and health, but give no clue as to why this is so.

In order to test the matter in another way maps of the entire Soviet Republic have been made on the basis of the remarkable new Russian census. In order to eliminate the differences between one area and another arising from differences in occupation, race, culture, degree of urbanization, percentage of the sexes, and differences in the age composition of the population, the present study has been limited to rural males of the ages of 19 and 20, 29 and 30, 39 and 40, and 49 and 50, and each racial group has been treated separately. Two types of data have been used, namely illiteracy, and the degree of accuracy with which ages are reported. The latter criterion appears to be the better of the two. Of course the persons aged 19, 29, 39 and 49 are normally more numerous than those aged 20, 30, 40, and 50. Nevertheless the people of Russia report their ages in round numbers so frequently that only in very rare cases do the census figures show

the normal condition. In the most backward areas the men aged 20, 30, etc., appear to be ten times as numerous as those aged 19, 29, etc. The maps prepared on this basis, as well as on the basis of illiteracy, agree with similar maps of the United States in showing a close agreement with what would be expected on the basis of the study of mental activity and the weather reported above. They also present very clear evidence of the influence of race, culture, and such physical conditions as mountains, deserts, and proximity to the sea.

PRESTON E. JAMES.

A Geographic Interpretation of the Coffee Lands of Middle Brazil.

The geographic interpretation of the coffee lands of Middle Brazil is approached through a study of the patterns of coffee distribution and a correlation of these patterns with the significant facts of the area which have been of importance in directing or influencing their development. In general, within the broad limits set by climate, the patterns in areas where settlement is primarily for the purpose of producing coffee, are linked more closely to the lines of communication than to any other fact of the area during period of expansion, but during periods of intensification the patterns which are related to the qualities of the soil and surface begin gradually to crystallize. It seems probable that the most recent extensions of coffee have penetrated areas where soil and climate are less suited to coffee production than in the *terra roxa* areas of central Sao Paulo state. As the virgin richness of the new coffee soils is gradually depleted a shrinkage of the coffee margin may be expected, and at the same time a further concentration on the *terra roxa* areas may take place with more careful and intensive cultivation. The economist is able to predict the swing toward intensification; the geographer can suggest the probable areas of concentration.

W. L. G. JOERG.

The New Era of Antarctic Exploration, 1928-1931: *A Summary of Results.*

With the end of the field season of 1930-31 (in April, 1931) the new era of Antarctic exploration ushered in with the use of the airplane seems to have come to a close, temporarily at least.

A summary of this relatively short period shows that, owing to the introduction of this new tool of exploration and as a result

of concentration of effort, as much, or more, was done in the way of revealing the major features of Antarctica as in each of the two preceding periods of organized activity in the Antarctic, namely 1901-04 and 1908-16.

The paper reviews the work of the Byrd, Wilkins, Mawson, and Norwegian expeditions which resulted in the delineation of most of the semi-circular outline of the continental landmass of East Antarctica and made new inroads into the unknown area of West Antarctica.

The exploration of the conjectured contact belt between these two different structural units and the determination of the character of West Antarctica as a whole remain the two most pressing unsolved problems as regards the distribution of land and water in the Antarctic.

The paper is illustrated by three maps in 1:12,500,000 showing respectively the routes of the expeditions of the field seasons of 1928-29, 1929-30, and 1930-31.

LOUIS C. KARPINSKI (Introduced by Lawrence Martin).
Significant Maps of Michigan.

The gradual evolution of the Great Lakes upon the map of North America by the united efforts of cartographers and explorers covers a period of some 300 years. The other outstanding features of the North American continent, such as the great peninsulas, Hudson's Bay, and the Mississippi River have a somewhat analogous historical evolution, including a succession of often quite incorrect delineations following somewhat correct ones.

Incidental to the final accurate delineation of the Great Lakes the present Michigan was subjected to three varieties of errors which because of their long persistence seem worthy of particular note:

Despite the fact that methods for determining latitude were well known yet the latitude of the southernmost tip of Lake Michigan vacillated over a distance of more than 100 miles for a period of 150 years. Two variant delineations of the Great Lakes, with wide variation in latitude of the tip of Lake Michigan, appear on different pages of the same atlas not simply in one instance but in a dozen widely used atlases from the beginning of the 18th century in Europe to well into the 19th century in Europe and America.

In the year 1718 the first scientific cartographer William Delisle

issued a map of Louisiane in which a high plain is placed running down through the center of the lower peninsula. An English cartographer goes so far as to join this plain, as a mountain range, to the Appalachian system. This high plain enjoyed more than a century of existence upon the map.

Another able cartographer, Nicolas Bellin of the French Marine, constructed in 1744 the maps to accompany Charlevoix's works on Canada. In a map of Lake Superior Bellin placed alongside of Isle Royale another equally large island, Isle Philippeaux. In addition other unusually large islands were placed in the eastern part of the same lake. These fictitious islands also enjoyed a century of this cartographical type of existence.

In view of such gross errors up to about 1840 in the mapping of Michigan it is obviously not necessary to apply any refined methods in discussing the evolution of Michigan upon the map. The story well illustrates the fact that the older makers of maps allowed themselves liberties which are quite inconsistent with scientific methods.

HENRY MADISON KENDALL (Introduced by Stanley D. Dodge).
The Fairs and Markets of the Department of Gers, France.

The fair and the town market still form the center of the economic and social life in the Department of Gers. Those at Auch are the largest, and all others are planned so as not to conflict with them. The area tributary to Auch includes a large portion of the Department and some area outside it. Four secondary centers exist and their umlands are partially inside of and partially outside of that of Auch. About each of the secondary centers, this arrangement is repeated on a smaller scale for tertiary centers. A definite pyramiding exists, with the fairs and markets of Auch capping the pyramid. The distribution of fairs and markets and the relationships existing among them throughout most of the Department aid in the description and interpretation of the landscape as distinct from those of surrounding regions.

JOHN B. LEIGHLY.
Toward a Theory of the Morphologic Significance of Turbulence in the Flow of Water in Streams.

The paper is an application to natural streams of some of the principles and methods developed in late years from the study of turbulent flow in the atmosphere and in laboratory models.

These studies have brought some of the grosser features of turbulent flow within the range of quantitative treatment.

An equation for the evaluation of the total shearing stress on the bed of a stream with uniform flow, whereby this shearing stress is equated to the energy supplied by the fall of the mass of water in unit cross section during unit time, has long been familiar in hydraulic literature. In the present paper, a method of differentiating this total expression is presented, with the aid of which the shear stress on any part of the stream bed may be determined, when the fall of the stream and the distribution of velocity in the cross section are known.

On the basis of determinations of the energy expended on various parts of the stream bed, in selected types of cross section, both symmetrical and unsymmetrical, conclusions are drawn concerning the tendencies toward change in any transverse profile. The transverse slope of the bed is shown to be a critical factor. The total shear stress on the bed, and the energy represented by the intensity of turbulence, are concentrated on the steeper parts of the transverse profile in the deeper parts of the stream. The recognition of this localization of energy throws light on the shifting of channels in meander bends and on the development of stable profiles on streams flowing in beds consisting of unconsolidated material.

The reaction of the material of the stream bed to the motion of water depends on its permeability and the size of the particle, qualities closely related in homogeneous material. Contrary to Gilbert's conclusions, turbulence is assigned prime importance in the forms of transportation denominated "traction" by him. The "traction" of sediment on the bottom of a stream is possible only because of a downward transfer of forward velocity, through turbulence, into the stratum of unconsolidated material.

The paper is illustrated by drawings of cross sections of streams, taken from published literature, on which the distribution of the intensity of turbulence is shown by isarithms, and by graphic illustrations of the methods and results of the computations carried out.

HENRY M. LEPPARD (Introduced by Chas. C. Colby).
The Carse of Gowrie.

The Carse of Gowrie, one of the two carses of Scotland, is an agricultural lowland extending for a distance of nearly twenty miles along the north side of the Firth of Tay between Perth

and Dundee. The plain, which averages about three miles in width, is flanked on the north by the Sidlaw Hills.

Agriculture is focused chiefly on the fattening of cattle and sheep, with the result that the greater part of the area is "laid down" to permanent grass. Wheat and seed potatoes are the principal cash crops, while turnips are grown extensively for late autumn and winter feed.

It will be shown that, though agricultural practices have certain regional characteristics which are related to natural conditions obtaining throughout the area, there also are striking subregional differences in farming methods which are adapted to local differences in soils and drainage.

SALVADOR MASSIP.

The Geographical Exploration of Cuba by Airplane.

The airplane has completely changed the methods of exploration of the polar regions. Mention is made of the flights of Amundsen, Wilkins and Byrd. The airplane is also applied to the exploration of equatorial and tropical regions. The author emphasizes the advantage of employing the airplane in the exploration and study of well known regions. Also states that there is no accurate map of Cuba and urges the Cuban Government to make a map of Cuba by aërial photography.

The author has made 19 flights over different parts of Cuba, with scientific purposes. These flights cover almost the entire island.

The city of Havana, from the air, looks like a conglomerate of cities rather than a single great city. The submerged terraces of the north coast are very clearly seen from the air due to the great transparence of tropical waters. They are more easily noted than the emerged terraces. Karst topography of the upper submerged terrace is notable. The author has confirmed Vaughan's hypothesis on the origin of Cuban bays. They are half drowned basins. The valley of the Yumuri is the head of a *coulisse*. The region shows three levels of peneplanation. The Pan de Matanzas is a monadnock. The valley of Güines is a living lesson of Human Geography. The term "valley" applied to Güines is arbitrary. The town of Güines is the centre of the economic life of the region. Four-fifths of the Cuban shoreline is swampy. It is covered by a salt water marsh of varying width. The marsh reaches its largest extent at the Zapata peninsula, on the southern

coast of Cuba. The structure of Northeastern Santa Clara shows a series of monoclinal ridges of tertiary limestone. Their summits resemble the "mogotes" of the Organos mountains of Western Cuba. The outstanding feature of the physiographic history of the Camagüey region is stability. This has produced a perfect peneplane. The region has a very sparse rural population and one isolated large city. The valley of the Cauto is a great syncline between the *coulisses* of Camagüey and of Santiago de Cuba. The Cauto is the largest river in the island. Natural levees and back swamps are conspicuous at its lower course.

The author acknowlelges the coöperation and support of the Cuban Army Air Corps and the Curtiss Aviation Company of Cuba.

FRANCOIS E. MATTHES.

An Interlude of Aggradation in the Cycle of Erosion of the Grand Canyon of the Colorado.

Clinging to the walls of Bright Angel Canyon and other side gorges within the Grand Canyon are remnants of gravel deposits showing that at a time geologically not remote the Colorado River and its tributaries, after having cut their gorges to substantially the present depth, filled them with coarse gravel and boulders to a depth of fully 150 feet. More recently the gravel has again been swept out of the gorges as a result of renewed degradation, but the process of reëxcavation is not yet completed. A considerable filling of old gravel remains in the lower portion of Bright Angel Canyon, and similar fillings exist in other side gorges. These facts indicate that a filling of considerable depth remains also in the trench of the master stream. That the Colorado River in the Grand Canyon is not cutting into bed rock at present is well known, but the reason for it has seemed puzzling. It would now appear that the river is flowing on a filling left from a recent period of aggradation.

The cause of the aggradation is still unknown. Investigations extending over a considerable part of the river's course and much adjacent territory will probably be required for its determination. Meanwhile the facts observed convey this lesson: that a cycle of erosion proceeding with sufficient vigor to produce narrow V-shaped gorges can be interrupted by an interlude of aggradation and then resume its course without the hard rock forms being sensibly affected. When ultimately all the gravel is removed from the V-shaped gorges no trace will be left of the interlude.

K. C. McMURRY.

Aeroplane Mapping on Isle Royale.

The mapping of Isle Royale has followed a rather different plan than that used in other geographic work in Michigan. Aero-photographs were made of the entire area. These photographs were studied, and from them typical areas, comprising less than one fourth of the total area, were chosen. These type areas were then mapped in considerable detail, by ordinary ground methods. From the data derived from the ground mapping, correlations are made with the aero-photographs, and interpolations made to the entire area. The results indicate a rather greater degree of accuracy than is attained by standard ground mapping, although the detail is somewhat less complete. The method appears to be one which may be used to advantage by geographers, particularly in areas where ground mapping is difficult.

O. M. MILLER (Introduced by W. L. G. Joerg).

An Experimental Survey of Oblique Aerial Photography.

This paper describes the methods of oblique aerial survey which were tried out for the first time this summer in Northern Labrador by an expedition under the auspices of the American Geographical Society which was organized and led by Dr. Alexander Forbes of Harvard University.

The considerations which decided on the particular methods that were used are explained together with the actual field work which was accomplished. An account is given of the procedure whereby a map is being constructed from the material obtained in the field.

Slides show the locality and extent of the survey, the routes taken on the photographic flights, the network of ground control points obtained and typical photographs.

RAYMOND E. MURPHY (Introduced by Glenn T. Trewartha).

A Coal Mining Valley in the Deeply Dissected Plateau Country of Southern West Virginia.

In southern West Virginia the deeply dissected plateau country drained by Tug Fork and its many tributaries is the scene of important coal mining activities. The valley of Elkhorn Creek is typical of this area in presenting two strongly contrasting landscape complexes.

A thin second-growth forest clothes the otherwise unutilized

upper slopes and divides of Elkhorn Valley, while in marked contrast to this are the lower slopes and narrow bottom lands of the main valley and its larger tributaries. Here, in an area amounting to only a small fraction of that of the upper slopes and divides, a dense population is arranged in a series of "shoestring" villages with scarcely a break between. Uniform frame construction as well as the presence of occasional large commissaries mark these as coal mining villages, and this character is borne out by the drift mouths, tipples, trains of loaded coal cars, and old coke ovens which are strung out along the narrow valley floor. The distribution of these coal mining landscape forms shows the restricting force of topography which is in evidence, also, in the courses of the highway and the Norfolk and Western Railroad, both of which follow the valley bottom, sharing its limited area with the houses and with a coal-laden stream. Confinement to valley bottoms gives to the cultural landscape features a distribution pattern which is dendritic like the drainage pattern of the plateau.

A few villages in Elkhorn Valley are not company-owned, but are independent trading settlements whose stores compete with the commissaries of the mining camps. These independent villages are predominantly of brick construction and show a high ratio of business houses to homes in marked contrast to the company villages, each with a single business building, the commissary. Relying as they do upon trade with the miners and their families, the independent villages are like the company camps in their dependence upon the natural resource, coal.

The assemblage of cultural forms of the valley floor is the surface expression of a vast underground network of intersecting tunnels where the actual operations of coal mining are carried on.

R. S. PATTON.

Recent Advancements in Coast and Geodetic Survey Methods.

(Published in full in this issue.)

RAYE R. PLATT.

Adventures in Map Making.

In their work of collecting and studying source materials for the American Geographical Society's Millionth Map of Hispanic America, the compilers of the map have had many experiences so unexpected and exciting as to be properly termed adventures. Their periodic visits to the cartographic departments of development com-

panies engaged in work in Hispanic America are always an adventure, because, although many of these companies attempt to keep the Society informed on the progress of their survey work, one frequently ferrets out in their collections surveys that solve problems in critical areas all but given up as hopeless.

One constant source of surprise is the accuracy in many sections of the well known series of maps of the West Coast countries of South America produced quite independently of each other by European cartographers during the third quarter of the past century. These maps—Codazzi's of Venezuela and Colombia, Wolf's of Ecuador, Raimondi's of Peru, and Pissis' of Chile—are still, with the exception of the Pissis map, the best general maps of the West Coast countries. The surprising thing about them is that, although the surveys assembled in them are, in each case, mainly the work of one man, these surveys should prove to be of such excellent quality where it is possible to compare them with more recent work.

Second among the surprises met by the compilers of the Millionth Map is the failure of compilers of general maps by Hispanic America to make accurate use (indeed, in most cases, any use whatever) of source materials of unquestionable merit and easy accessibility. Surprising also are the many areas in Hispanic America that, though long settled, must still be rated as unexplored from the cartographer's point of view.

Frequently the best materials for a given area come from the most unexpected sources. A steamship company keeps up-to-date a large scale survey of the Amazon River from its mouth to Iquitos yet neither the U. S. Hydrographic Office nor the British Admiralty has made any use of this survey on their charts of the river. Often explorers who do no accurate mapping keep such careful notes that fairly good detail can be constructed from them. Most discouraging of the discoveries of the compilers of the Millionth Map is that many maps excellently drawn and reproduced and long looked upon as source material of high quality prove to be only copies of indifferent maps with their only real merit the excellence of their reproduction.

But the real adventure to compilers of the map comes when, having attempted by careful study to construct a cartographic picture of a section of country from a collection of materials of various kinds—each poor enough in itself but possessing some features of merit—such as sketch maps, written descriptions, physio-

graphic information, meteorological data, and the like, an aviator checking the compilation from the air or a subsequent survey proves it to be accurate in its essential details.

ROBT. S. PLATT.

Copper Mining Pattern of Terrene Occupancy in the South Range, Keweenaw Peninsula.

A report of field study by a group from the University of Chicago in August 1931. Its purpose is to present mining geography as distinct from economic geology and mining engineering. The heart of the South Range is seen to be a chain of four mines in relation to which other features of the cultural landscape fit into the natural background to form a functioning pattern of terrene occupancy, part of the larger pattern of the Keweenaw Peninsular Copper Country. Every feature of the pattern represents a solution of problems connected with copper production.

The mines themselves represent a solution of problems of ore discovery and extraction, depending on distribution, orientation, form, and character of ore bodies, and on circumstances conditioning the supply of mechanical equipment, timber, water, power, and people. The development of an intricate transportation pattern is involved in this, and the railway is the chief factor in unification of the area to form the South Range district.

Another problem reflected in the pattern is elimination of waste matter, comprising 99% of the rock mined. Solution of this problem is seen in rock piles at the mines; in stamp mills on the Lake Superior shore taking in hundreds of tons of water and discharging several tons of pulverized rock for every ton of copper concentrate produced; and in a smelter near the port of Houghton consuming lake-borne coal and producing marketable copper.

The final problem solved in the pattern is shipment of the product to market, represented in the focal facilities and transportation lines which function with reference to problems already mentioned, and finally in the dock located at the nearby port where the Portage Lake waterway crosses the copper bearing lodes.

Thus the general pattern of the South Range appears as an areal functional unit, developed in accord with the circumstances of the district. Furthermore, the pattern is seen to have distributive individuality befitting its natural setting not only in general but also in the particular details of every feature: in the local complexity and texture of shafts, drifts and stopes, and in the

peculiar form and place of buildings combining to form the focal establishments and ultimately the whole copper mining pattern of terrene occupancy in the district.

SIDMAN P. POOLE (Introduced by Robt. S. Platt).

Human Adjustment in the Chama River Valley of the Venezuelan Andes.

The Syracuse University Expedition to the Venezuelan Andes had amongst its objectives the study of settlements in the high river valleys—those in the Chama particularly. This stream rises near the Paramo of Apartaderos (4,100 m.) and flows southwest between the Sierra Nevada de Merida and the Sierra del Norte. Its valley is partly erosional and partly (?) structural. From its source to Merida it is narrow, youthful and with an average gradient of 40 m. per km.

Nearly every town in the state is located in the higher valleys, several being along the upper Chama. Agriculture is the basic industry, with little mining or manufacturing. This distribution of people with a single industry illustrates certain simple and yet unique adjustments to the environment.

1. *Climate.* The surrounding lowlands have high average temperatures throughout the year with their rains coming from June to September. Elevation reduces temperatures, gives greater diurnal changes and introduces climatic zones based on altitude, thus making possible the cultivation of a greater variety of products. A more stimulating climate with diverse agricultural possibilities is reflected in the concentration of population in these mountains.

2. *Topography.* Within the valley topographic features have affected adjustments. River terraces, several hundreds of feet thick in places, and alluvial fans, built out into the main valley tributaries, provide the sites for towns. Since the Pleistocene, streams have cut canyons through these loosely cemented gravels. Neither on the mountain slopes nor in the gorges is farming possible but only on the flat terraces.

3. *Transportation.* Through the Chama valley passes the Transandean highway from the seacost to Colombia. It follows the old mule trails over the lowest and most feasible passes. Secondary mule paths make use of the valleys of tributary streams. The alluvial fans of the latter are thus the foci of local trade routes.

4. *Irrigation.* Most of the tributary streams flow from small glaciers. During an eight months dry season these provide the necessary water for the crops. Only on the terraces and the fans are there deep soiled flat lands so located topographically that water can be led to them. Here are the farms and the villages.

5. *Historic Impetus.* These adjustments antedate the conquest. Every settlement is on the site of an old Indian village. The Spaniard introduced his language, religion, new crops and customs. But he continued the fundamental adjustments of the Indian. Agriculture remains the one industry and it is carried on in the same places and in the same way. Not only are these adjustments probably the best under the circumstances but they are almost the only ones possible if people are to live in the valleys at all.

JOHN K. ROSE (Introduced by S. S. Visher).

Effects of Climate upon Corn Yield in the Chief Corn Growing Areas.

Climographs for representative areas in the important corn growing regions of the world disclose several relationships between the various climatic elements and the yield. On the assumption that increasing yield indicates approach to optimum climatic conditions, the graphs shown suggest the effects on the yield which may be expected to follow various departures from the optimum climatic conditions. These effects vary somewhat with the area considered because soil type, cultural methods and corn varieties differ considerably.

L. R. SCHOENMANN (Introduced by Preston E. James).

Planning for Land Use in Northern Michigan.

Adequately comprehensive land inventories are a dependable basis for pointing acreage demanding land uses to the particular land areas that are physically adapted to occupancy by such uses. Rural planning proceeds to weigh the several possible uses for each land area of individualistic physical character on the balances of economic environment and social need to determine the particular use or combination of uses which will yield the most satisfying product or function.

In consequence, rural planning develops a variety of land use patterns that show a strikingly close correlation with physical character in most instances and a seeming disregard in certain instances.

ALBERT L. SEEMAN (Introduced by Geo. T. Renner).

The Geonomics of the Proposed Columbia Basin Irrigation Project.

The geonomics of the proposed Columbia Basin Irrigation Project must determine in the final analysis the feasibility of the project. Thus far, most of the surveys, reports and investigations have concerned themselves chiefly with engineering and technical possibilities. This paper discusses the economic-geographic aspect objectively and from a long-time viewpoint.

To answer the question "Will it pay?" two factors must be considered. The first of these considers the productive capacity of the area and the second includes the ability to dispose of possible commodities after they are produced.

Such factors in the environment as climate, soil, relief and water supply determine the productiveness of a region. This 80-square-mile tract of land possesses a mild climate with sufficient heat and an adequate growing season for many crops. The soil has been declared suitable for irrigation by the U. S. Bureau of Soils, the U. S. Geological Survey and the U. S. Engineer's Department. Much of the surface will have to be altered but there are no obstructions which cannot be overcome. The Columbia River has a sufficient supply of water to furnish additional water for this irrigation project without jeopardizing the existing projects depending on the waters of the Columbia River.

The ability to produce crops does not guarantee, however, the ability of this region to be a financial success. That will be determined by the markets in (1) the immediate vicinity, (2) the Pacific Coast States, and (3) the United States at large. The estimated 1960 per capita consumption and the estimated population for the various areas named above are the chief items used in solving this problem. The 1960 populations are prognosticated for the various consuming regions; those results serve as a basis for determining the 1960 market. The 1960 year is used as a basis because the project cannot be completed before that time.

In comparing the market data for 1960 with the 1960 estimated supply of corn, barley and oats there is revealed a deficit for the United States and the Pacific Coast states. However, in the case of wheat there will be a surplus; the deficit in other grains is approximately eight times as great as the wheat surplus.

On the same basis of calculation the estimated meat supply sug-

gests a tremendous meat shortage in 1960. Thus a market is assured for any grain or meat produced from the irrigated area other than wheat.

In the case of horticultural products no such result is obtained. The high yields of garden truck and fruit crops makes it possible to greatly increase these productions in various localities without materially reducing the acreage needed for other products.

Thus if this 2,000,000-acre tract of land is developed in small units so as not to ruin the pioneering farmers the project can be an economic and financial success. This is particularly true if the proposed pumping plan is put into operation so that power will pay a large share of the necessary costs. A more equitable tax proposal—such as is to be used in California—will further increase the desirability of developing this marginal land.

GUY-HAROLD SMITH.

Cartography in Philately.

The hobby of stamp collecting should be of more than casual interest to geographers. The map stamps in particular have sufficient geographic character to permit serious study. On a large number of stamps the map is only an incidental part of the decorative scheme. In others, however, the map has a particular significance. Islands, such as Ireland, Iceland, Cuba, Réunion, New Zealand, Newfoundland, Cyprus, and even Australia have been rather faithfully represented on postage stamps. The use of map stamps by Bolivia and Paraguay, and by Roumania and Bulgaria is a means of calling the world's attention to the disputed areas claimed by the two countries involved. The rapid growth of air mail has made the map a useful motif for the air mail adhesives. These are well illustrated by recent stamps from Russia, Newfoundland, Venezuela, Greece, Spain and others. The readjustment of political boundaries and the anniversaries of changes in territory are occasions which call for the map as an adornment of philately. Newfoundland's recent stamp shows the boundary of Labrador as defined by the Privy Council in 1927. In the Canadian series commemorating the confederation this same boundary is shown with the expansion of Canada in the period between 1867 and 1927. The 1930 commemorative series for Greece shows the addition of territory during the preceding century. These samples serve to illustrate the use of cartography in the designing of postage stamps.

GUY-HAROLD SMITH.

Washington's Camp Sites on the Ohio River.

In the autumn of 1770 George Washington and a small party journeyed down the Ohio River as far as the Kanawha, which they ascended approximately fifteen miles, and then returned to the junction with the Ohio. Then began the tedious journey upstream against the strong current of the swollen Ohio. It was on the 20th of October, 1770, that Washington and his companions left Pittsburgh for the Kanawha, and it was on the 21st of November that they returned to Pittsburgh, requiring a month and a day for the journey.

The exact location of Washington's camp sites along the Ohio is a problem which has never been completely solved. The specific sites of a limited number of his camps may be located on large scale maps, but locating them in the field is almost impossible. From his journal these camp sites may be indicated but a large number cannot be located so definitely. In a few cases the position along the river is known, but he failed to record on which side he camped. The interpretation of his journal permits us to specify the probable location of his camps in a few cases.

His journal for the days of November 7 to 16 inclusive has been so injured that it cannot be read without an undue amount of interpolation. During this ten-day interval, as well as on other occasions it is impossible to give more than a very approximate location of his camps. It is possible then to classify our knowledge of his camp sites under the four categories mentioned above.

FLOYD A. STILGENBAUER (Introduced by S. Van Valkenburg).

Cartography and the New Population Map of the United States.

The function of a population map is to give a correct impression of the areal distribution, density, agglomeration, and group relationship of people. A population map is indispensable in the study of modern geography.

People agglomerate in proportion to the ability of the geographic complex to provide means of a livelihood. To map clearly a population which varies from 3,989 people in Nye County, Nevada, to 2,560,401 in Kings County, N. Y., is difficult. Divisions of population are arbitrary. Rural, Rural-Urban, Urban, and Metropolitan Urban are portions of the transitional "Rural to Urban" scale. Rural people reside in agglomerations up to 2,500;

Rural-Urban, 2,500 to 15,000; Urban, 15,000 to 750,000; and Metropolitan Urban, 750,000 or more. These divisions are for cartographic convenience only. Immediate lands provide approximately 75% or more of the Rural livelihood, 50% of the Rural-Urban; 25% of the Urban, and 15% or less of the Metropolitan Urban.

Experiment has proven that similar surfaces as defined in the dot-and-circle system tends to minimize generality and obscurity of expression, and preserve the naturalness, accuracy, and clearness of feature desired in the population map. In actuality the scale would vary from an invisible point to a circle 3¾ inches in diameter if dots were used for both small and large groups. Where population is dense and sparse, generality tends to lend clarity and accuracy of expression. The unit dot for the U. S. map of 40 miles to the inch is the area occupied by 2,000 people uniformly distributed in family groups having ample simple housing and garden space. All larger and more complex groups are represented by circles of similar area in proportion to the number of people. Solid black circles to 15,000 and hollow shaded circles beyond, tend to clarify expression. All groups below 2,500 are classed as rural and so mapped. The 500 break forms the basis of difference allowed in the size of the unit rural dot as compared with the smallest urban dot of 2,500 people, to conform with the census division and facilitate the reading of the map.

The tendency of the city to over-run the contiguous smaller center has brought about a legitimate use of the metropolitan idea in cities of 100,000 or more. A metropolitan district includes the central city and all surrounding contiguous minor civil divisions having a density of not less than 150 inhabitants per square mile, but may include divisions of lesser density if surrounded or closely connected. Only cities of 750,000 people or more are charted as metropolitan districts with added insets showing detail.

HELEN M. STRONG.

The Proposed Inter-American Highway Through Central America.

The Pan-American Highway extending from Ottawa, Canada, to Buenos Aires, Argentina, has long been a dream. Because it is a vast undertaking, planning has been concentrated on the "Inter-American Highway," extending from northern Mexico to Panama.

It is the purpose of this study to reveal present adjustment to the physical environment and to permit a forecast of trends.

Central America comprises more than 200,000 square miles, largely rugged. The mountain ranges are distinct from those of South America and from those of Mexico and the United States. In the north they trend east-west, meeting the northwest-southeast ranges of the south in Nicaragua. Volcanoes extend across the western ends of the ranges near the Pacific Coast of Northern Central America, then south-eastward to Northwestern Panama. The Pacific coastal lowlands are narrow and the ascent from them to the mountains and plateaus is steep. The Caribbean slopes are broad, but traversed by many ranges and valleys. The Caribbean coastal fringe is low and narrow. Pacific slope rivers are short, torrential, and navigable only at the mouth. Rivers of the Caribbean slope are comparatively long, flowing across rapids in the mountains, and through tidal reaches before entering the Caribbean. They are navigable in their tidal portions for launches, and between the rapids of the upper reaches for smaller craft. Sand-bars obstruct the mouths of many rivers.

The pattern of the land surface has determined the development in some places of roads, trails, and settlement, and the isolation of other regions, inaccessible under present conditions.

The climate of the highlands is temperate, with moderate seasonal rainfall. Hence the population has become concentrated there. Access has been principally from the Pacific ports, since the jungle-covered Caribbean slope has precluded all but the most arduous travel. The Pacific Coast has sub-tropical temperatures, and marked seasonal rainfall. During the wet season streams overflow, frequently changing their channels, making it difficult to maintain a permanent road surface for highways or roadbed for railroads.

The Caribbean slope awaits detailed exploration. The banana industry is on the Caribbean coast, where some roads and narrow-gauge railroads have been built. In banana towns are roads and automobiles. Travel elsewhere must be on mule, horseback, or afoot. Eastern Central America will be opened as modern transportation, sanitation, medicine and engineering develop its forests, minerals, grazing and agricultural lands.

The Inter-American Highway will connect two contrasting regions: the United States and South America. This will be an

element in the development of passenger travel and freight transportation over the route.

C. WARREN THORNTHWAITE (Introduced by Preston E. James). *The Climates of the World.*

A quantitative classification of climates, developed by the author, has already been applied to the United States and North America (Geogr. Rev. vol. 20, pp. 306-307, and Geogr. Rev. vol. 21, pp. 633-655). New climatic elements, precipitation effectiveness and temperature efficiency were employed and means for computing them were developed. In the present study climatic data for the entire world were collected and were analyzed on the basis of the previously derived equations. About 4,000 stations were classified and were located on a world map. On the basis of these stations climatic boundaries were drawn, and a tentative map of world climate was constructed. The theoretical or ideal distribution of the thirty-two climatic types was represented on a map of the generalized continent.

GLENN T. TREWARTHA. *The Prairie du Chien Terrace: Geography of a Confluence Site.*

The fragment of outwash terrace within the Mississippi gorge, upon which the historic town of Prairie du Chien stands, is situated just north of the junction of the Wisconsin river with the Mississippi. This confluence terrace has been persistently occupied by a white settlement since before the Revolutionary War and for three-quarters of a century earlier had been the intermittent rendezvous of the French *coureurs de bois* and the Indians as they bartered for furs. An Indian village, a frontier fur-trading community for nearly a century and a half, a military post under three flags, a bustling river and railroad town of commercial fame in the mid-nineteenth century—each of these successive tenures profited from the river location and the confluence site, and to a degree they all had their origins rooted in these facts of situation. The present town is a dormant community, with the same locational facts which were the *raison d'être* for the earlier forms of settlement now acting to circumscribe its services and handicap its prosperity.

The author contends that a morphological study of any area requires no defense since it deals with a portion of the earth's

surface. The Prairie du Chien Terrace derives new interest because of the antiquity of its occupation and the variety of its cultural successions.

EUGENE VAN CLEEF.

Pioneer Settlement in the Baltic Countries.

With the establishment after the Great War, of the independence of Finland, the New Baltic States, and Poland, immediate consideration was given by each of the countries to effect the utilization of certain lands theretofore not cultivated. During the Russian regime, vast areas incorporated within private estates were never developed.

Each of the countries invoked a plan whereby the estates were divided into small parcels and the people encouraged to purchase them on a long-term credit basis. Although theoretically removed from the pioneer class for many decades, these lands now reverted to a pioneer status. Their present occupance presents an opportunity to observe pioneer settlement in old countries.

An attempt has been made in this paper to designate geographically, the limits of the pioneer fringe.

S. VAN VALKENBURG.

Morphological Observations on Young Mountains.

In a paper read by title only and published only in abstract [Annals A. A. G. XIX (1929), 50-51] an explanation was given for the existence of longitudinal valleys in young mountain systems with special reference to the Swiss Alps. In that same year F. Machatschek [Zeitschrift der Gesellschaft für Erdkunde zu Berlin] opposed the explanation given and suggested another solution. In this paper the author defends his opinion. The field work has been extended into the French Alps where similar relief features were observed; a comparison could be made with other similar structural valleys as the Sumatra Riftvalley and the reason for the later uplift and warping can be deduced from a new explanation of the process of mountain building given by F. A. Vening Meinesz [Tijdschrift Aardrijkskundig Genootschap, Amsterdam, September 1931].

J. O. VEATCH (Introduced by K. C. McMurry).

The Soil Factor in the Geography of Lakes.

The description of land (using the term in a restricted sense as opposed to water covered surfaces) is not regarded as being com-

plete by the geographer, unless the relation of the land to man is also considered. The human significance of land is related in a vital way to the plant growth, but the full significance of the plant growth cannot be appreciated unless the basic factor of soil is considered, nor can the land be properly classified into natural geographic divisions, nor according to agricultural value without the recognition of soil as a factor. An analogous case is presented for water covered surfaces such as lakes, streams, marshes. Aquatic and amphibious plants may have a direct use to man for food, fiber and chemical products, and an indirect use, since they furnish food and protection to fish, waterfowl, aquatic fur-bearing and domestic animals. The nature of the plant growth, as in the case of the dry land, is related to the soil. Water soils have hitherto received very little attention either from the pedologist or from the biologist. A tentative classification of water soils is proposed in which the water soil in general is recognized as being composed of three major horizons: (1) the surface aqueous; (2) the subaqueous or cumulose; (3) the basal geologic substratum. It is possible to establish types of water soils, analogous to terrene soils.

S. S. VISHER.

Generalizations as to Territorial Expansion, A Study in Political Geography.

In the hope that generalizations will stimulate thought and the gathering of facts to test the validity of the generalizations, and hence to an increased study of Political Geography, the following hypotheses were presented, examples given, and their causes discussed: (1) countries tend to include some sea coast; (2) superior seaports tend to be incorporated into the stronger country nearby if they can serve it advantageously; (3) active countries tend to expand into the sea to include nearby islands and sometimes coastal areas opposite; (4) a natural geographic unit tends to become a political unit; (5) areas having similar culture tend to unite politically; (6) geographically favored regions tend to become strong countries; (7) weaker countries may be annexed to stronger ones, not the reverse; (8) the number of independent political units tends to decrease; (9) the more favored regions geographically tend to influence increasingly the less favored; (10) political control is of increasing significance.

J. R. WHITAKER (Introduced by R. H. Whitbeck).

Sault Ste. Marie, Ontario and Michigan: A Comparative Study in Urban Geography.

These two cities are areas of more than usual interest. A canal traffic of unparalleled intensity flows between them. Their situation on the border between the Laurentian Upland of Canada and the Interior Lowlands of the United States is particularly significant because of the absence of other border towns at suitable crossing places within a distance of 600 miles. Though small, both are regional capitals of importance, and, due to growth in manufacturing during the last three decades, industrial centers as well. Not the least challenging is the evidence pointing to a long series of changes since the origin of the settlements as an Indian fishing village at the foot of the St. Mary's Falls, changes in the cultural landscapes, in the utility of site elements, and in the services performed for the tributary area. The interpretation of this development is facilitated by the opportunity for comparative analysis.

The study deals specifically with (a) the sites as modified by human agencies, (b) the symmetrical arrangement of urban features with respect to the riverway, (c) major contrasts between the two cities, and (d) individuality and interdependence. Although they occupy similar sites and are markedly alike in structure, each city is an independent organism, with a separate trade area. Differences are due, primarily, to the contrasted politico-economic conditions under which the two cities have evolved.

R. H. WHITBECK.

The Agricultural Geography of Jamaica. (Published in full in this issue.)

R. H. WHITBECK.

Washington's Only Journey Outside of Continental North America.

In September, 1751, George Washington and his half brother, Major Lawrence Washington, gentleman proprietor of Mt. Vernon, sailed for Barbados in the hope of finding restoration of health for Lawrence. The outbound journey of five weeks, the six-weeks' stay in the island, and the return journey of five weeks are described in a diary kept by George Washington, then a youth of nineteen. While in Barbados he contracted smallpox but

escaped without serious disfigurement. Lawrence failed to improve, tried the climate of Bermuda, and later returned to Virginia where he died within a few months leaving his Mt. Vernon estate of 2,500 acres to his half brother, George.

Selected excerpts from the diary and a brief account of economic, social, and military conditions in this small but important British colony make up the paper.

DERWENT WHITTLESEY.

Trans-Pyrenean Spain.

The classic example of the ideal mountain boundary is the Pyrenees. Nevertheless, there are exceptions to the watershed as the boundary line. One of the more important of these is the Vall d'Arán, the valley at the head waters of the north-flowing Garonne River which nevertheless has been Spanish since the establishment of the Pyrenees boundary in 1659.

Investigation of the reasons for this exception divulges the fact that throughout the Middle Ages the Pyrenees was not a political boundary, but that political units or federations occupied both flanks indifferently, at times extending to or beyond the margin of the piedmont. In contrast, the Pyrenees was a boundary in Roman times, as it has also been during the modern period.

The explanation of the paradox appears to lie in a delicate balance of environmental forces. High pastures used in common by dwellers in valleys on either flank of the mountains tend powerfully to create socio-political units of adjacent valleys reaching down from the watershed. On the other hand, stiff gradients and deep snow for eight months a year tend to separate people inhabiting opposite sides of the mountain crests or watersheds.

With forces of the environment thus in equilibrium, political unity within the mountain corresponds with periods of local autonomy (e.g., the Middle Ages), whereas in periods of powerful sovereignty centered on adjacent plains, the crest or watershed boundary becomes the accepted political division.

The Vall d'Arán being, of all the north-facing valleys of the Central Pyrenees, the most closely affiliated to Spain, by virtue of a large watershed grassland and an easy pass-route, and at the same time being somewhat cut off from the piedmont section of the Garonne valley by steep-walled mountain spurs, has become a political anomaly.

FRANK E. WILLIAMS.

Crossing the Andes at 41° *S.*

The problem of crossing the Andes has always been a serious one. The mountains to the south are generally lower and the belt narrower than farther north, but even here there are difficulties of steep slopes, bodies of water and narrow canyons. The route which follows roughly the parallel of 41° S. Lat. crosses not only the Andes but traverses a few of the bodies of water which are found in the Andean lake region, both of Chile and Argentina, which is one of the most remarkable in the world. This route was followed by soldiers and Jesuit fathers over two hundred years ago when the journey was a much more painful and dangerous one than it is at present. The trip by boats, automobiles and horse is now very easy and pleasant. In a very short distance one leaves the partially developed southern valley of Chile, passes the pleasant farms of the Germans, crosses one low range of mountains and four lakes and reaches the rolling pastures of western Patagonia.

FRANK J. WRIGHT.

Harrisburg Erosion in the Older Appalachians.

The floor of the Appalachian Valley has long been regarded as a peneplane produced during one of the later erosional cycles. The names Harrisburg Peneplane and Valley Peneplane, rather than Tertiary Peneplane, are now applied to this surface. It rises in elevation from about 900 feet near Chattanooga, Tennessee, to 2,600 feet on the divide between New and Holston Rivers in southwest Virginia.

The Harrisburg erosion surface in the Appalachian Valley is apparently connected genetically with mature valleys and even local peneplanes in the Older Appalachians. The Asheville local peneplane is one of the best in the Southern Appalachians. It is possible to find traces of the former mature valley of the French Broad River which connected this high-lying local peneplane with the regional peneplane of the Appalachian Valley. The unity of history is particularly well shown in the basin of the New River where it is possible to follow in the field the Harrisburg Peneplane from the Great Valley, underlain by soft rocks, up into the more resistant crystalline area of the Older Appalachians. These relations are also clearly indicated by a series of projected profiles covering a large area.

Since the local basins in the mountains stand at elevations of 2,000 to 4,000 feet, some observers have assigned them to different cycles of erosion. The writer believes that their varying elevations above the Valley Peneplane are due to differences in stream length, stream volume, rock resistance, and the presence of rocky barriers across the streams. Elevation is not a satisfactory basis for correlating these levels because of their great range in altitude, and also because the Harrisburg surface in some localities stands higher than the Schooley in others.

The Piedmont Peneplane has often been referred to the Harrisburg and it is here correlated with the Valley Peneplane and with the extensions of the Piedmont and Valley surfaces in the form of mature valleys and local peneplanes in the Older Appalachians.

The correlation of these diversified levels is based on, (1) unit in erosional history as shown in the basins of the New, French Broad and other rivers, (2) striking similarity of the topographic features wherever the Harrisburg surface was developed, (3) intrenched meanders in almost all of the Harrisburg basins, and (4) stream gravels preserved on remnants of the Harrisburg Peneplane.

JOHN K. WRIGHT.

A New Atlas of the Historical Geography of the United States.

In 1932 the Carnegie Institution of Washington and the American Geographical Society expect to publish what will probably be the most comprehensive historical atlas of a single nation that has yet appeared: Dr. C. O. Paullin's *Atlas of the Historical Geography of the United States.* Plans for the *Atlas* were formulated nearly thirty years ago by Professor J. F. Jameson and other American historians. Dr. Paullin, of the Division of Historical Research of the Carnegie Institution, was put in charge of the work in 1913, and in 1929 an arrangement was made whereby the American Geographical Society accepted the responsibility of bringing the enterprise to a close. Besides editing and seeing the entire publication through the press, the Society has rearranged all the material and added a considerable number of new maps.

The *Atlas* will measure about 14½x11 inches and will contain about 225 pages of maps and 150 pages of text. The great majority of the maps are based upon wholly original research. The text explains the symbols shown on the maps, discusses the sources upon which they are based and the manner in which they were constructed, but, except incidentally, does not interpret or explain the maps in historical terms.

The primary problem in any historical atlas is how best to record movement and change by means of the more or less unsuitable medium of the map—essentially a picture of static conditions. Three devices may be used. The simplest is the series or sequence of maps revealing progressive stages in a single process. The *Atlas* contains many such series—for example those showing density of population for every census year and the vote at every Presidential election. Another device is to show on a single map conditions that prevailed or events that occurred at different dates —such as the *Atlas* maps of boundary disputes and military history. The third device is that of the map summarizing a total amount of change during a given period. This device is used only on a series for increase and decrease in improved land since 1850, but might well be more widely employed in historical studies.

The maps in the *Atlas* may be classified in three groups: (1) maps illustrating certain outstanding facts of the natural environment as a setting for American history; (2) maps illustrating the material expansion, so distinctive of American history (exploration,. settlement, land grants, boundary disputes, growth of the physical bases of economic life); and (3) maps illustrating aspects of our history, such as the distribution of political sentiment, the trend of reform movements, and religious and military history.

Exhibits at the Ypsilanti Meeting

A notable feature of the twenty-eighth annual meeting of the Association of American Geographers was a series of cartographic exhibits which comprised several hundred maps and other graphic items. Most of the materials were conveniently displayed in a large hall adjoining the rooms where the sessions were held. Supplementary exhibits were installed at the University of Michigan in Ann Arbor, twenty minutes from Ypsilanti.

The largest single exhibit was a series of early printed maps from the collection of Dr. Louis C. Karpinski, professor of mathematics in the University of Michigan. One section of his show consisted of city plans, chiefly of European cities, illustrating the evolution of the mode of depicting urban forms. A group of maps of the world, of the Americas, and of individual continents formed another section of this display, while a third lot of maps covering parts of Eastern North America, particularly the Great Lakes Region, emphasized the gradual dawning of accurate knowledge of that area. Most of the maps shown bore dates prior to 1800.

In the main lobby of the library of the University of Michigan, Professor Karpinski had arranged, also from his collection, a display of school geographies and atlases, chiefly from the 18th and the very early 19th centuries. The early use of nearly every title now current among geographic textbooks was illuminating.

Paralleling the selection from the Karpinski collection was a display of geographic Americana, which occupied the entire foyer of the William L. Clements Library at the University of Michigan during the period of the Association meetings. This exhibition, arranged by the director of the Library, Dr. Randolph G. Adams, included the Blaeu atlas, as well as numerous equally famous and many less known individual maps illustrative of the early days of America. A prized section of this display consisted of a number of manuscript maps and plans made by officers engaged in colonial wars of North America, including the Revolution.

Several United States government bureaus prepared exhibits showing examples of their recent cartographic work and new series of maps which they have undertaken.

The display of the United States Geological Survey, planned

by Drs. Matthes and Campbell, included examples of the latest topographic maps, as well as samples of other series, such as the water-resources and the land-utilization maps. Particularly interesting were the maps on the larger scales (e.g., 1:24,000) recently adopted for cities and other special areas, and the charts of George Washington's battlefields, issued this year as a bicentennial memorial. A feature of this exhibit was the display, side by side, of early and recent topographic maps of identical areas, on the same scale. This tellingly brought out improvements which the Survey has achieved in representing topographic items, particularly landforms.

The United States Coast and Geodetic Survey likewise and with similar spectacular effect presented comparative examples of old and recent work, as well as a number of the newer maps issued by the Survey. The extraordinary degree of detail shown on these maps is a revelation to those who are making acquaintance with them. This exhibit was prepared through the courtesy of Captain R. S. Patton.

The United States Department of Agriculture, through Dr. O. E. Baker, was represented by a series of maps (chiefly dot maps) and graphs which disclosed the distribution and trends of a variety of agricultural phenomena between the years 1909 and 1929. These charts, although of the sorts made well-known by fifteen years' effective use in publications of the Department, included new data which, by their variety, gave fresh significance to the utility of this form of graphic presentation.

The cartographic enterprise of the American Geographical Society was given expression in three series of maps, prepared for exhibition by Mr. W. L. G. Joerg. One of these consisted of the map of Hispanic America, on a scale of 1:1,000,000. Although this series is familiar to most geographers, the display showed that it now forms a large collection. The much smaller but nevertheless surprisingly large cartographic output covering polar research of recent years made up the second series of maps exhibited by the Society. The third consisted of proof sheets of the forthcoming historical atlas of the United States which is the joint product of the Society and Dr. C. O. Paullin of the Carnegie Institution of Washington.

In addition to the collections of early maps and books, and the exhibits of the output of staffed organizations, there were showings of current manuscript maps of several individual workers.

Both the organized groups and the individuals disclosed notable originality in their attempts to portray distributions and intensities of mappable data. In the nature of their activities the institutions, having underaken a procedure, are bound to follow it out. Thereby a great part of their work becomes compilation pursuant to a more or less standardized plan. Individuals, on the other hand, are free to experiment, and accordingly their manuscripts, while small in aggregate number, stood out as decidedly thought-provoking suggestions. The frontier of geographic thinking must inevitably lie along the border of the cartographic unknown. Hence the value of these exhibits by individuals exceeded their volume.

Professor D. H. Davis showed a series of dot-population maps of Minnesota which expounded decennial distribution and intensity from 1850 to 1930 inclusive.

Professor Guy-Harold Smith introduced a novelty in the form of a display of postage stamps which bear geographic phenomena.

At the University of Michigan the Department of Geography threw open its workrooms. Besides many printed maps used in the laboratories, there were on view manuscript maps recently completed by members of the Department and their advanced students. These dealt chiefly with the depiction of settlement and other forms of terrene occupance.

This series of varied and comprehensive exhibits was complemented by a considerable list of papers discussing or amplifying the materials displayed. Most of these papers were conveniently grouped into a morning session, with which the annual meeting was opened. Apart from the exhibits described above, there were the usual excellent graphic illustrations of paper after paper. These always comprise an exhibit in effect, but since they appear seriatim and for a few moments only, their aggregate variety and volume is not called to attention. If they had been included in the standing exhibition, its size and scope would have been even more impressive than it was.

Finances of the Association of American Geographers

ROBT. S. PLATT, *Treasurer*

The following statement has been written for the ANNALS at the request of the Council, after the annual meeting at Ypsilanti, where the Treasurer's Report for the past year (December 16, 1930 to December 15, 1931) was audited and accepted.

The income of the Association has been from four sources:

ANNALS subscriptions and special orders	$1141.48
Membership dues	870.00
Sinking Fund income	81.97
Joint Research Fund income	316.19
Total income	$2409.64

The expenses have been of three sorts:

ANNALS publication	$1658.49
Secretary's expenses, including annual meeting	300.00
Treasurer's expenses, including bond premium	28.10
Total expenses	$1986.59

The excess of income over expenses, $423.05, will be used in paying for the last number of the ANNALS in 1931.

Notes on the sources of income.

The amount credited to ANNALS subscriptions is unusually large because including some of the subscription income for 1930 as well as that for 1931.

Dues for 1931 have been paid by all but 12 members. There are at present no members who have to be dropped for two years' nonpayment of dues.

The Sinking Fund consists of life membership payments invested to provide income from life members equivalent to the annual dues from other members. Any other member may become a life member upon payment of $150. Since no such payments have been received during the past year, there has been only a small addition to the fund, $33.11, from two sources:

Profit on sale of securities	$17.75
Interest on bank account	15.36

This brings the total amount of the fund to $2077.75.

The Joint Research Fund was entrusted to the Association of American Geographers by the American Geographical Society when the latter society discontinued direct support of the ANNALS. The income is exclusively for publication of the ANNALS. The fund has been increased during the past year by the addition of $223.57 from 3 sources:

Sale of old ANNALS by the American Geographical Society	$138.07
Profit on sale of securities	68.50
Interest on bank account	17.00

This brings the total amount of the fund to $6424.64, an important nucleus of endowment for the ANNALS.

The securities held in the two funds had on December 15, 1931, an average market value 15% below their purchase value. In view of current market conditions, this does not seem unsatisfactory. The funds are intact and producing income; there has been no default and there has been a profit on each security disposed of.